In-Harbor and At-Sea Electromagnetic Compatibility Survey for Maritime Satellite L-Band Shipboard Terminal

August 1974

prepared for

National Aeronautics and Space Administration (NASA)

Goddard Space Flight Center

Greenbelt, Maryland

under sponsorship of

U.S. Department of Commerce (DOC)

Maritime Administration (MARAD)

Contract NAS5-24035

Order No. 953-W99870

(NASA-CR-139131) IN-HARBOR AND AT-SEA ELECTROMAGNETIC COMPATIBILITY SURVEY FOR MARITIME SATELLITE L-BAND SHIPBOARD TERMINAL (RCA Service Co., Inc.) 1 HC $6.25 CSCL 17B G3/32

N75-10284

Unclas 53016

Government Services Operations

RCA Service Corporation

Springfield, Virginia

FOREWORD

This technical report was prepared in the RCA Service Company, Government Services Operations facility, Springfield, Virginia on NASA Contract NAS5-24035. The work was administered under the direction of Mr. Ralph E. Taylor, Code 953, Mobile Radiodetermination Branch, Goddard Space Flight Center, Greenbelt, Maryland.

The survey reported herein was initiated in May 1974 and concluded in August 1974. The activity was carried out by James S. Hill with the assistance of Ernest C. Powell, Jr.

The author would like to acknowledge a number of helpful suggestions from Ralph E. Taylor, Daniel L. Brandel and James F. Cottrell of the NASA Goddard Space Flight Center from Commander Harry Feigleson of the Department of Commerce, Maritime Administration, Orest J. Hanas and Richard Husta of AII Systems, Incorporated, and Captain William Kolbe and Donald E. Kadlac of the United States Lines.

TABLE OF CONTENTS

LIST OF PHOTOGRAPHS

LIST OF PHOTOGRAPHS (Continued)

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1. Introduction

Two, geostationary, maritime satellites, one over the Pacific and one over the Atlantic Ocean will make available high-speed communications and navigation (position determination) services to ships at sea (e.g. Reference 1). A shipboard satellite terminal, operating within the authorized maritime L-band, 1636.5 to 1645.0 MHz, will allow ships to pass voice, teletype, facimile and data messages to shore communication facilities with a high degree of reliability. The shore-to-ship link will also operate in the maritime L-band from 1535.0 to 1543.5 MHz.

A significant number of maritime/commercial ships are expected to be equipped with an L-band satellite terminal by the year 1980. Consequently, there is an interest in determining electromagnetic compatibility (EMC) between the proposed L-band shipboard terminal and existing, on-board, shipboard communications/electronics and electrical systems, as well as determining the influence of shore-based interference sources.

The shipboard, electromagnetic interference (EMI) survey described in this report was conducted on-board the United States Line's American Leader class (15,690 tons) commercial container ship, the "American Alliance" from June 16 to 20, 1974. Reference 2 describes the Test Plan. The 1.2 meters (m)-diameter (4 Ft.),

Ref.1: David W. King, "Satellite Telecommunications-Marisat" pp. J1-J9, 1974 Florida RTCM Assembly Meeting, Radio Technical Commission for Marine Services, Washington, D.C. 20554.

Ref.2: "EMC Test Plan for Shipboard In-Harbor and At-Sea Measurements for L-Band Terminal", 12 June 1974, prepared for NASA/Goddard Space Flight Center, Greenbelt, Maryland by RCA Service Company on NASA Contract-24035.

paraboloid antenna, duplexer, low noise amplifier and down converter of a prototype L-band shipboard terminal were used in a series of EMI measurements to investigate interference to the ship's 10 cm wavelength (S-band) and 3 cm wavelength (X-band) radars, as well as potential interference to the L-band shipboard terminal. Field intensity measurements from 1-10 GHz were made; also, conducted emissions were made on the ship's power lines using a field intensity meter in the frequency range of 150 kHz to 32 MHz and a spectrum analyzer in the range up to 100 MHz. For comparison measurements were also made on land-based power lines in the frequency range of 150 kHz to 32 MHz.

Field intensity measurements were made at several locations suitable for installation of the L-band terminal on the ship's flying bridge and on the radar mast, as well as in a below-deck equipment storage room where part of the L-band shipboard terminal may be installed near two radar cabinets. An evaluation was made of band-pass and low-pass microwave filters installed in the L-band terminal to alleviate potential interference.

Antenna sky-noise temperature measurements were made at 1.6 GHz using the L-band shipboard terminal and a Dicke radiometer type microwave noise-power test set. Measurements were made at sea and repeated again in USA harbors where land-based noise sources received by antenna back-and side-lobes increased the apparent sky-noise temperature.

2. Description of Equipment

Portions of an operational L-band shipboard terminal were supplied for the survey by AII Systems, Incorporated, Moorestown, New Jersey, under a Maritime Administration contract.

The typical L-band shipboard terminal has an above deck complement housed in a radome consisting of a steerable 1.2 m diameter dish antenna, an L-band transmitter, a duplexer, a low-noise amplifier (LNA) and power and control elements. The below deck equipment includes a down converter with local oscillator and modems for communication services such as telephone, teletype and facsimile as well as special distress, warning and navigation services.

For the purpose of this shipboard EMC survey only certain basic parts of the L-band shipboard terminal were required. The equipment supplied by AII Systems, Incorporated, consisted of the following:

1. One 1.2 m (4 Ft.) diameter parabolic dish reflector, containing a RHCP feed for L-band (1535 to 1660 MHz) operation. The RF feed was circularly polarized (right hand, RHCP) and the antenna gain was 24 dB above an isotropic at 1559 MHz. The antenna was mounted on a hand-steerable, azimuth-elevation tripod mount containing a yoke with a neck to fit the tripod clamp.

2. One TACO antenna mounting tripod, counterweighted and provided with graduated scales for positioning the antenna in azimuth and elevation.

3. One duplexer adjusted for a receive test frequency of 1559 MHz and a transmit test frequency of 1659 MHz (e.g. Ref. 3) used in ATS-6 satellite experiments. Insertion loss is 0.5 dB with

Ref.3: "System Design Plan for Modifications of the Maritime Satellite System (Phase III)" Maritime Administration, U.S. Dept. of Commerce Report No. MAR044-P-002A, Issued December 7, 1973.

a bandwidth of 20 MHz. There is 90 dB isolation between the transmit and receive ports.

4. One low-noise amplifier (LNA) with a noise figure of 3 dB and a gain of 29 dB. The 3 dB bandwidth is 190 MHz and the amplifier reaches 1 dB compression at 029 dBm input.

5. One 5 MHz master oscillator and phase locked loop. These items were not a part of the prototype L-band terminal but were available substitutes.

6. One down-converter to convert from 1559 MHz to an IF of 50 MHz. This unit is not part of the L-band terminal but is an available substitute. A typical operational L-band down-converter has an IF output of 70 MHz.

7. One power supply cabinet. This unit provides +24 V, +15 V, and -15 V power for the LNA, down-converter, master oscillator and phase locked loop.

8. One low-loss 1/2 inch diameter Foam Wellflex coaxial cable, 12 m long. The cable loss at 1559 MHz is 1.4 dB.

9. Band-Pass Filters, one with a band centered at 1559 MHz to use between the LNA and the down-converter and one centered at 50 MHz for the output of the down-converter.

10. Low-Pass Filters to insert in the system to control possible harmonic and spurious emission interference. These filters have a maximum insertion loss of 0.7 dB and a 3 dB bandwidth of DC to 2000 MHz.

A measurement made on the overall system from the duplexer antenna port to the down-converter output showed a gain of 42.5 dB at 1560 MHz. The 3 dB bandwidth was 6.87 MHz and the system noise figure was 5.9 dB.

An antenna stand was fabricated of "erector set" type of structural steel by NASA. This stand raised the base of the antenna tripod off the deck by 1.8 meters and put the swivel axis for the antenna 2.8 meters above the deck so that the antenna main lobe could clear the railing and surrounding obstructions.

The characteristics of the two radars installed on the "American Alliance" are given in Table 2-1. The radar antennas were located on the radar mast and platform. Photo 1-1 shows the S-band radar antenna on the top of the mast and the X-band radar on the forward end of the platform. The L-band 1.2 m diameter dish antenna can be seen below the platform. Direct line from the L-band antenna to the S-band antenna is 9.2 meters and to the X-band antenna 7.4 meters.

Table 2-1 Radiomarine Radar Characteristics

	S-Band Type CRM-N2C-30	X-Band Model CR-104A
Frequency, MHz	3050	9375
Peak Power, KW	30	40
Range, Nautical Miles	0.5, 1, 2/6, 16, 40	1, 2, 4/8, 20, 40
Pulse Duration, μs	0.1/0.4	0.25/0.65
Rep. Rate	2000/1000	2000/800
Average Power, W	6/12	20/20
Receiver BW, MHz	12/3	2.5/8
Power Tube	6043 Klystron	725A Magnetron

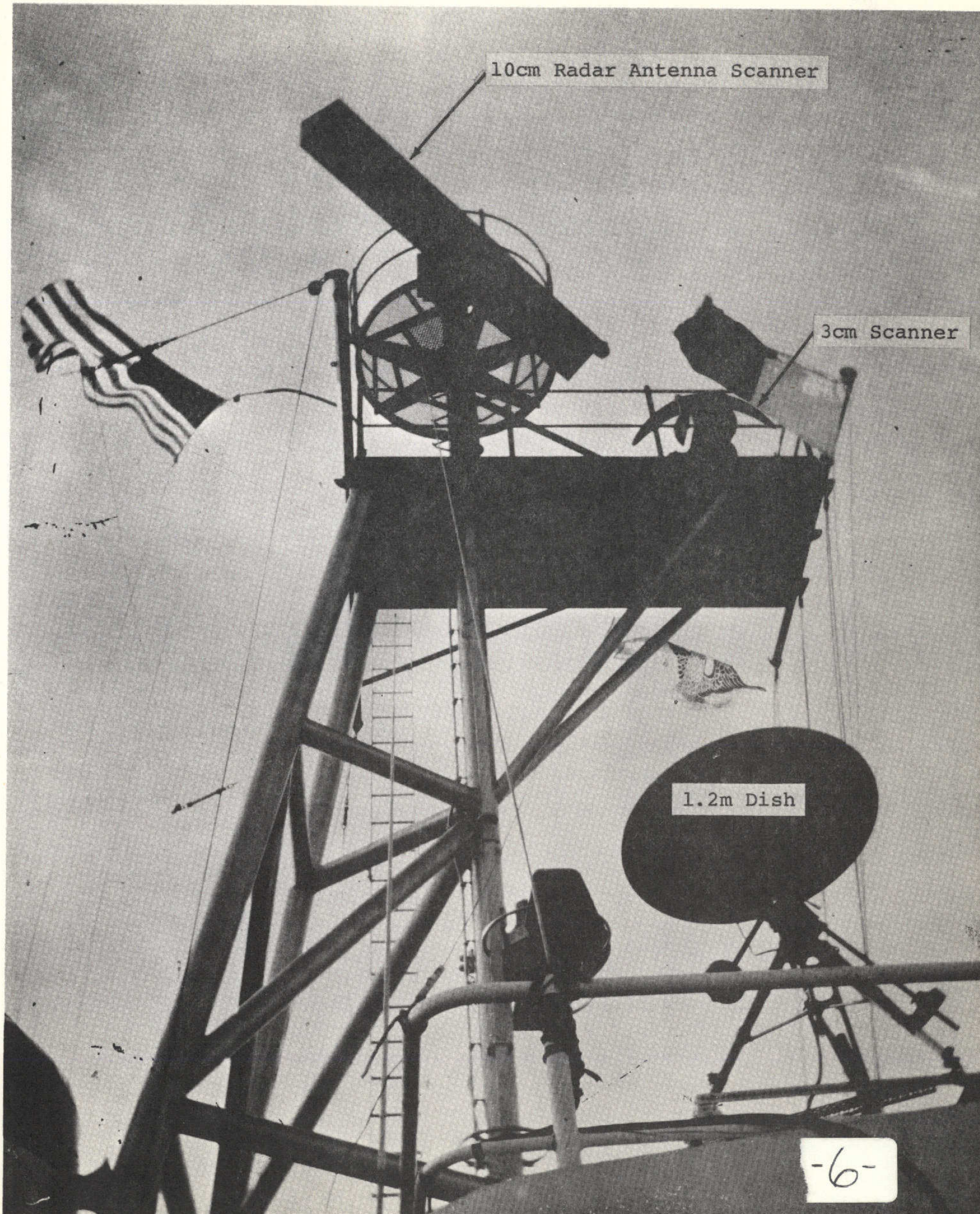


Photo 1-1, Radar Antennas and Shipboard Satellite Terminal Dish Antenna

Photo 1-2 shows the wheelhouse port side. The two radar displays appear in the center of the photo with the curtains partially drawn. Photo 1-3 shows the wheelhouse starboard side. The survey instrumentation was located in the far corner where the spectrum analyzer and oscilloscope camera can be seen in the photo. The deck just below and aft of the flying bridge is shown in Photo 1-4. The HF whip antenna on the left is used to receive on 4, 6, 9, 12, 16, and 22 MHz while the top loaded vertical antenna is used to transmit on these same frequencies. A UHF coaxial antenna is mounted on the port-side, king post and the long wire antennas are used in the MF range, 410 to 512 kHz. Photo 1-5 shows the "erector set" antenna stand that was designed to elevate the L-band tripod and antenna above the railing. The antenna stand was lashed to the deck with wire rope.

3. <u>Instrumentation</u>

Four basic sets of instrumentation were used.

(1) Singer Stoddart NM-25T Radio Interference and Field Intensity Analyzer. This instrument covers a range of 150 kHz to 32 MHz. It was used with the Stoddart RF clamp-on current probe to measure power line conducted emissions.

(2) Singer Stoddart NM-65T Radio Interference Analyzer/Receiver. This instrument was used as a two-terminal voltmeter to measure signal and noise levels in the L-band terminal. It was also used with an L-band standard horn antenna and with a log-spiral conical antenna to measure field intensity in the storage room and above deck.

Photo 1-2, Wheelhouse, Port Side

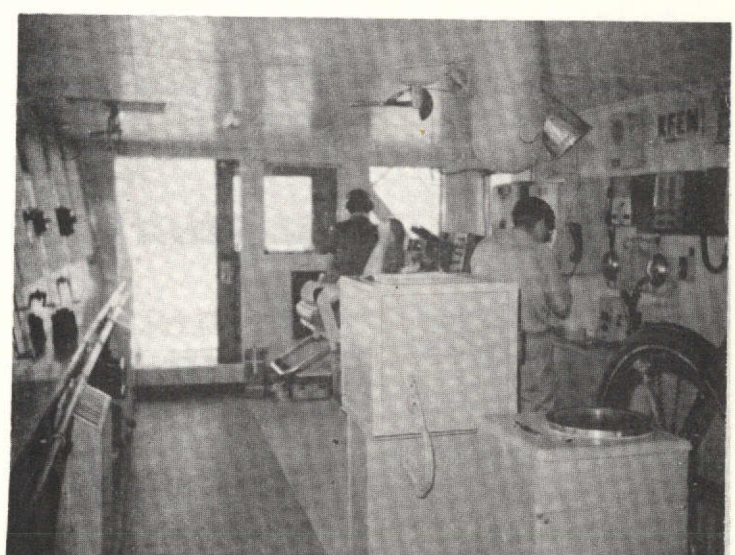


Photo 1-3, Wheelhouse, Starboard Side

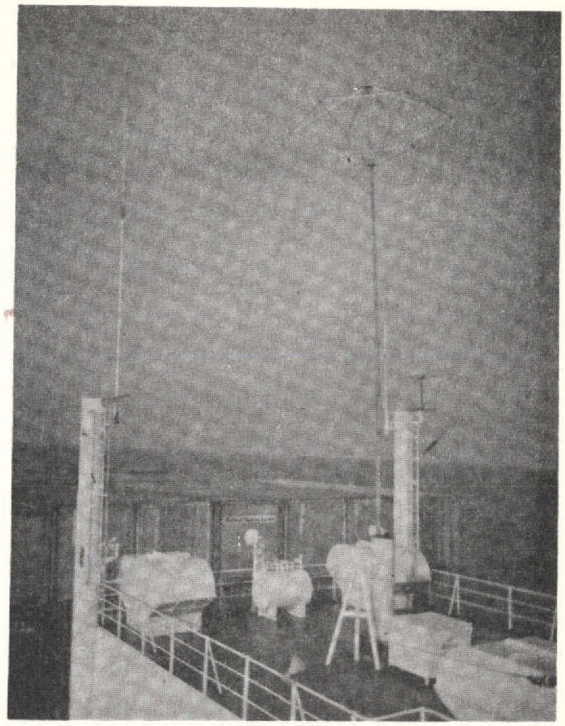


Photo 1-4, Antennas on Afterdeck

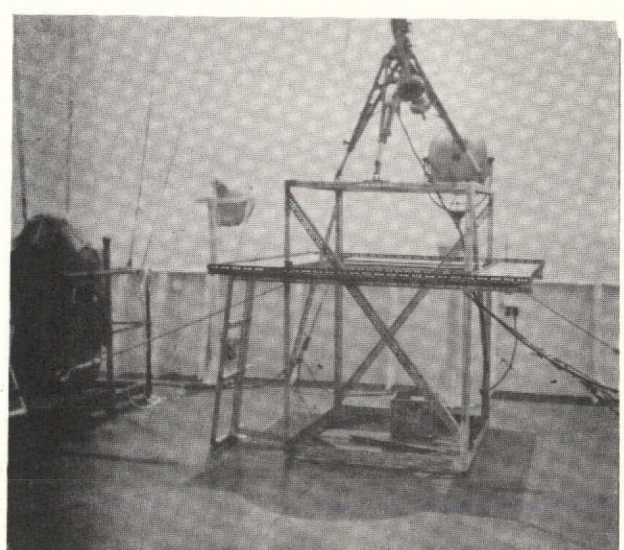


Photo 1-5, Antenna Stand with Tripod

(3) Hewlett-Packard Spectrum Analyzer consisting of the 8445B Automatic Preselector, 8555A Tuning Section, 8552B IF Section, 141T Variable Persistence Display Section, and a 196B Oscilloscope Camera. This instrument was used as a two terminal voltmeter to measure signal and noise levels in the L-band terminal. It was also used with the standard antennas to measure field intensity and with the clamp-on current probe to measure conducted emissions.

(4) AIL Type 2392B Radiometer Serial No. 124. This instrument was used as a noise power meter to establish a reference level of noise power from the L-band antenna and to match this reference level with noise power from the cold reference load through the ARRA Variable Attenuator Model 5614-60L, Serial No. 37. The Hewlett-Packard 7034A X-Y Recorder was used as an output indicator with the radiometer.

In addition to these basic systems the following ancillary items of equipment were used.

EMC Model 1000 tripod and pan-tilt head

EMC Model 1010 horn antenna, 1-2.5 GHz

EMC Model 1200 log-spiral conical antenna, 1-10 GHz

Hewlett-Packard Model 7034A X-Y recorder, serial no. 948-00112

Composite cold reference 50-ohm load

AIL type 124 power oscillator, 200-2500 MHz.

All instrumentation which was used for voltage level measurement was within the calibration period.

4. Description of Measurements

All of the measurements were made on-board the ship "American Alliance". The survey team boarded the ship when it docked at Port Elizabeth, N. J., at 0600 hours on Sunday June 16, 1974 and started the measurement program while the ship was docked. The measurements were continued while the ship was underway to Tioga Terminal in Philadelhpia, PA, continued while the ship was docked there, while the ship was underway to Savannah, GA, and concluded with the ship docked in the Savannah harbor.

Five different categories of measurements were made as planned for the survey. Each of these was designed to collect specific information required for development of plans for the installation of the L-band satellite terminal on shipboard with a minimum amount of mutual interference with shipboard systems. The conducted emission measurements should be helpful to equipment designers to prevent possible interference with the L-band terminal from power-line conducted interference. The field intensity measurements show the potential of interference from the radar-radiated signals to the L-band terminal located near the radar platforms or on the starboard side of the flying bridge. Field intensity measurements made near the radar cabinets in the storage room should help the designer determine the degree of shielding required in the L-band terminal equipment cabinet. Filter evaluation measurements give information on the effectiveness and requirement for additional filtering in the front end, radio-frequency (RF) section of the L-band terminal. The antenna sky-noise temperature measurements give galactic (natural) and man-made noise-level information. The possibility of interference to the radars by the L-band system was investigated by observation of the radar displays while a simulated L-band terminal signal was radiated.

A detailed description of these measurements is given in the following subsections.

4.1 Conducted Emissions

This test was run to investigate the conducted emission on the ship's power lines so that power line filters could be specified if required for the L-band terminal. For a comparison, measurements were also made of conducted emission on a power line in the RCA calibration laboratory, Springfield, Virginia.

The conducted measurements were made on the two radar units located in the storage room directly below the wheelhouse. Photos 4.1-1 and 4.1-2 show the S-band radar (left) and the X-band radar (right). A Stoddart clamp-on probe was clamped around each input power line on both radars to sample the interference current. Photo 4.1-3 shows the clamp-on probe coupled to an X-band radar power line. In Photo 4.1-4 the probe is coupled to an S-band radar power line. A tunable RF voltmeter, the Stoddart NM-25T, was used with the probe to investigate the spectrum from 150 kHz to 32 MHz. The Stoddart NM-25T is shown in Photo 4.1-5 with the H-P model 7034A X-Y recorder which plotted a chart for each of the 8 bands covering the 150 kHz to 32 MHz range. Since the intermediate frequency output of the L-band terminal down-converter is 70 MHz there is an interest in power line conducted emission near this frequency. The H-P 141T spectrum analyzer in combination with the Stoddart current probe was used for this purpose.

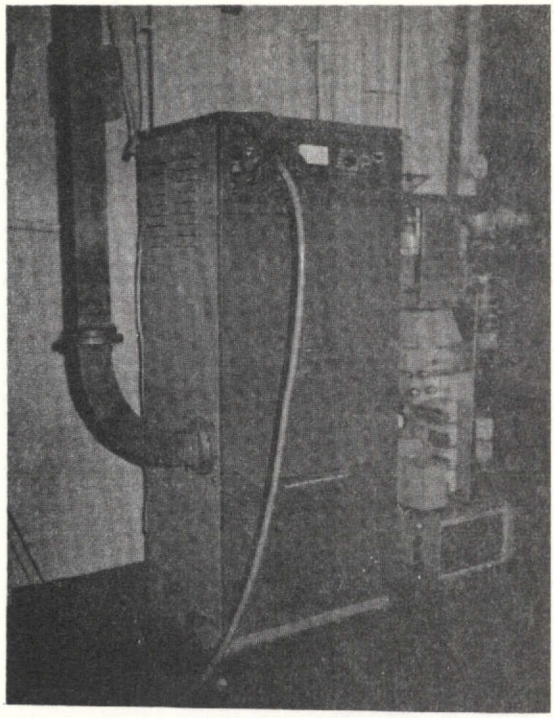


Photo 4.1-1, S-Band Radar
Cabinet in Foreground

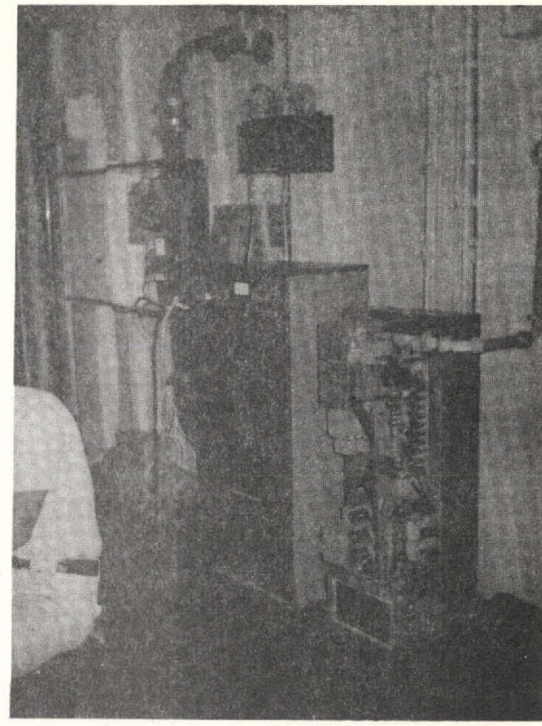


Photo 4.1-2, X-Band Radar
Cabinet in Foreground

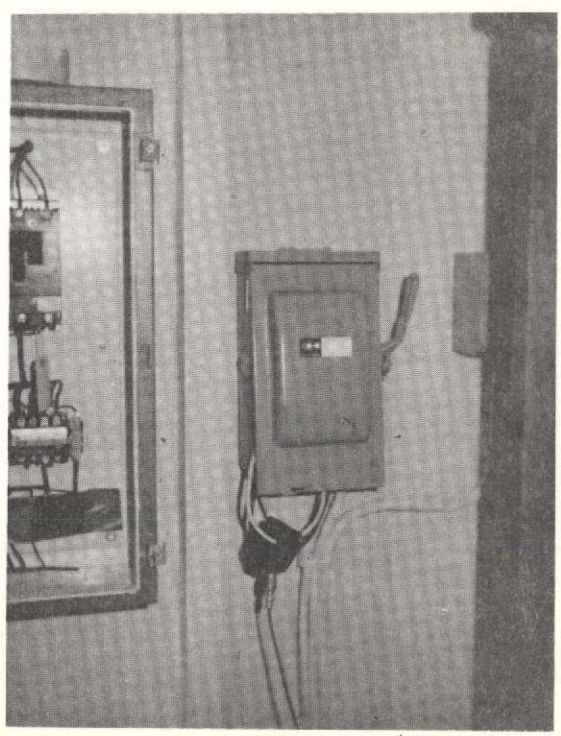


Photo 4.1-3, Current Probe on
X-Band Radar Power Line

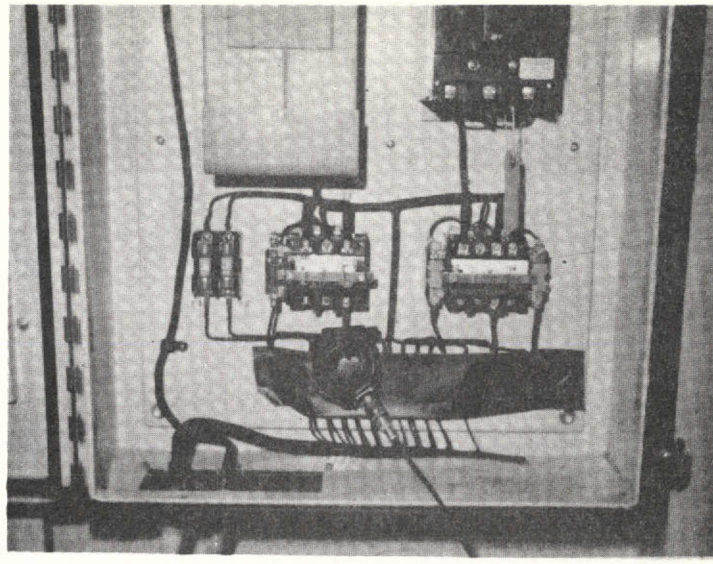


Photo 4.1-4, Current Probe on S-Band
Radar Power Line

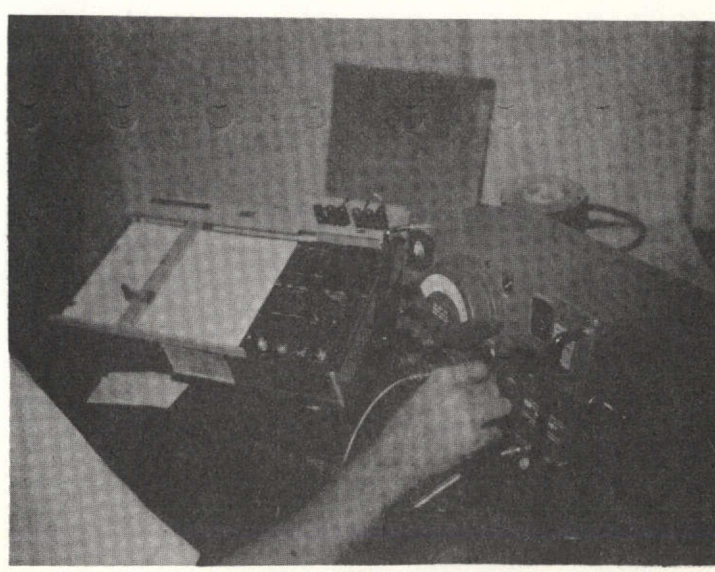


Photo 4.1-5, H-P 7034A X-Y Recorder
and Singer Stoddart NM-25T

4.1.1 Conduct of Test

Measurements were made on the X-band radar power lines while the radar was operating. A chart was made for each band of the NM-25T in the field intensity (FI) and again in the quasi-peak (QP) mode. In some cases, it was possible to run both records on one chart. After making the measurements on the black and white power lines, the two sets of results were compared; it was evident that they were similar and that either describes the interference existing on the power lines.

Consequently, the first measurements on the S-band radar T1 and T2 power lines were examined to determine if they were independent. Because of the similarity, only one line, T2, was measured completely. As a basis of comparison, the conducted emission on a similar power line in the RCA calibration laboratory was measured; a complete set of FI and QP charts was made on the black power line.

The resulting charts are included in Appendix A. Charts A-1 through A-15 were taken on the black power line, while Charts A-16 through A-30 are for the white power line of the X-band radar. The results of the S-band power line measurement are shown in Charts A-31 through A-41. Charts A-42 through A-52 were obtained in RCA's laboratory. Following the charts are the Spectrum Displays. Spectrum Displays A-1 and A-2 show the conducted emission from 0 to 100 MHz on the S-band and X-band radar power lines respectively as coupled into the clamp-on current probe; the reference level in each case being -30 dBm. Spectrum Displays A-3 and A-4 were made at a center frequency of 70 MHz with 5 MHz per division scan width to give a more detailed picture of the interference near 70 MHz, the reference level being -50 dBm.

4.1.2 Analysis

The X-Y charts have a vertical scale in decibels referenced to one microvolt, meter scale. To this has been added the attenuator setting, which in this set of measurements is -20, zero, or +20 dB. The FI trace on the chart can then be read in terms of decibels referenced to 1 μv (db/μv) for a two-terminal voltmeter. The QP trace must be adjusted by the attenuator setting plus 46 dB* as a bandwidth compensation factor to give the broadband emission level in dB/μv/MHz. In order to convert the chart data to decibels referenced to 1 μA (dB/μA), an adjustment must be made for the transfer impedance of the current probe. The calibration curve for the current probe is shown as Chart A-53. The adjustment factors for the bands have been quantized as shown on the chart. The adjustment for the first band, 0.15 to 0.305 kHz is 8 dB. Since the current, I, is equal to the voltage, E, divided by the impedance, Z, or I=E-Z (in dB), the adjustment factor is subtracted from the sum of the meter reading and the attentuator setting. For the broadband conducted emission level in dB/μA/MHz the bandwidth compensation factor of 46 dB* must be added. A similar data reduction process is employed for each band using the proper current probe transfer impedance factor.

Spectrum Displays A-1 through A-4 require an adjustment factor for the transfer impedance of the current probe in addition to an adjustment for bandwidth. Reference is made to Chart A-53 for the current probe transfer impedance. The bandwidth was adjusted by adding 20 dB to convert from 100 kHz (spectrum analyzer bandwidth)

*For impulse type broadband interference the data is a function of instrument impulse bandwidth. The impulse bandwidth of the NM-25T is 5 kHz. The bandwidth adjustment factor, BWF, to convert this data to the conventional dB/μv/MHz is determined as follows:

$$\begin{aligned} BWF &= 20 \log 1\text{ MHz} - 20 \log BW \text{ (dB)} \\ &= 60 - 14 \text{ dB (for BW of 5 kHz)} \\ &= 46 \text{ dB} \end{aligned}$$

where BW the bandwidth of the measuring instrument to 1 MHz bandwidth. Thus at 70 MHz the adjusted level is:

	S-band	X-band
from display	-89 dBm	-90 dBm
conversion to microvolts	107	107
	18 dB/μv	17 dB/μv
current probe factor	-14	-14
	4 dB/μA	3 dB/μA
bandwidth adjustment	20	20
conducted interference	24 dB/μA/MHz	23 dB/μA/MHz

4.1.3 Comments

Conducted emission measurements showed that the ship's power lines were "noiser" than the commercial power lines in the RCA Service Company Calibration Laboratory, which would be considered as average for an industrial park area.

A comparison of QP and FI traces will identify transients and impulsive type emissions where peaks exist only on the QP trace and are not in evidence at the same frequency on the FI trace (see Charts A-16 and A-17). The shipboard power lines evidenced broadband conducted emissions (QP) that were typically 50 dB higher than the RCA power line in the lower frequency part of the range (compare Charts A-17 and A-42). In the upper part of the frequency range the shipboard power lines were 25 to 30 dB higher than the RCA power line (compare Charts A-29 and A-52). Narrowband conducted emissions did not differ by as much but if protection from conducted emission levels is required in new shipboard installations, the protection must be designed to protect from the most severe condition.

Notes were entered on some of the charts indicating time related transients as well as other identified interference sources such as foreign broadcast stations.

The spectrum display photos which show the spectrum from 0 to 100 MHz give a good overall "look" at the conducted emission level and its frequency distribution (see Spectrum Display A-1 and A-2). These measurements were made while the ship was at sea. Conducted emission on the power line may possibly be more intense while the ship is in the harbor with loading machinery operating.

4.2 Field Intensity Measurements

Field intensity measurements were made using the Singer Stoddart NM-65T Radio Interference Analyzer with a standard horn antenna for the L-band measurements and a broadband log-spiral conical antenna for the 1 to 10 GHz frequency range. Data was recorded on an X-Y recorder. Both field intensity (FI), average value, and direct peak (DP) were recorded on each chart. Measurements were made in three locations; (1) in the storage room where the radar cabinets were located, (2) on the starboard side of the flying bridge at a location indicated in Figure 4.2-1, and (3) two sites each 1.2 meters outboard of the radar platform (one starboard and one aft).

4.2.1 Storage Room Location

The S-band (10 cm) and X-band (3 cm) radar transmitter cabinets are both located in a storage room below the wheelhouse. Since this is the proposed location for part of the L-band shipboard terminal, there is an interest in the electromagnetic environment in which the L-band system would operate to determine effective shielding requirements. The measurements were made with the measurement antenna positioned one meter in front of each radar cabinet, as shown in Photo 4.2-1.

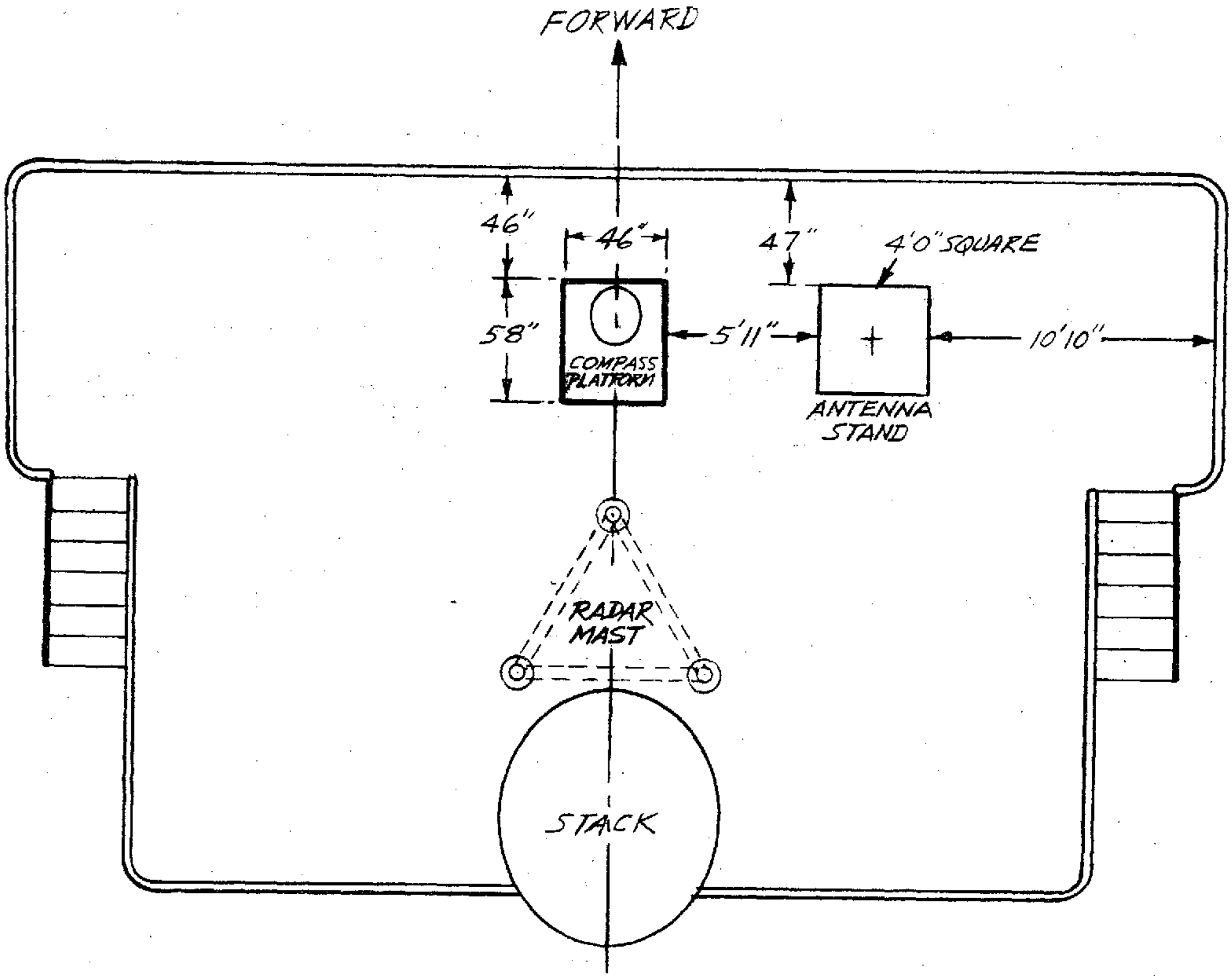


FIGURE 4.2-1
TOP VIEW OF FLYING BRIDGE
AND LOCATION OF ANTENNA STAND

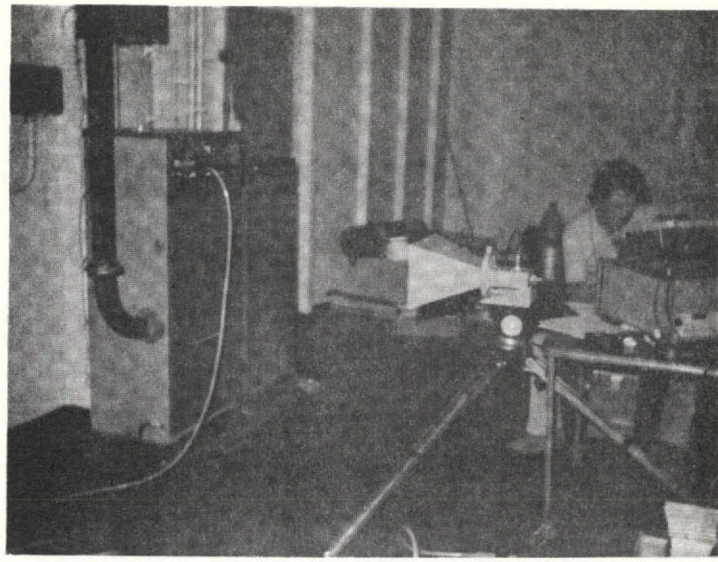


Photo 4.2-1, Radar Transmitter Cabinet Field Intensity Measurements with Horn Antenna

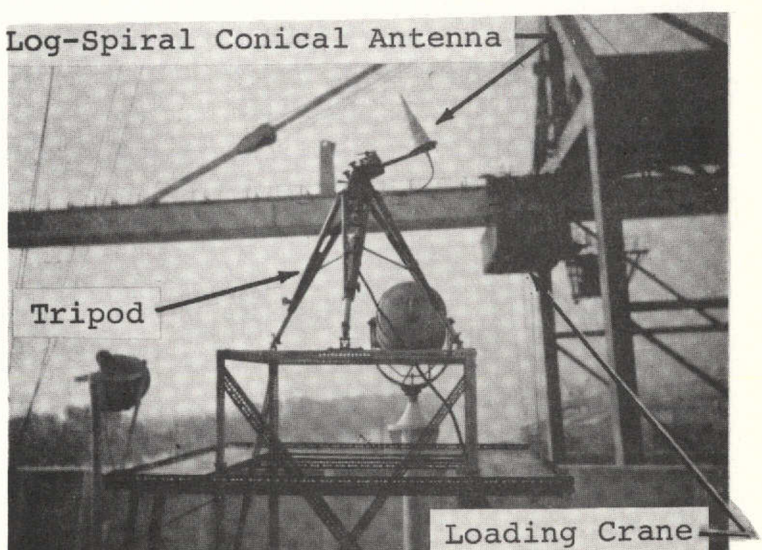


Photo 4.2-2, Field Intensity Measurement with Log-Sprial Conical Antenna on Starboard Side of Flying Bridge

4.2.2 Flying Bridge Location

Measurements were made on the flying bridge at a location approximating the location on which an L-band terminal is being installed on a ship of the American Leader Class. These measurements will show the level of field intensity from the radars that must be withstood by the L-band terminal. As expected, the measurements indicate a worst case when the radar antennas face the L-band terminal antenna. Photo 4.2-2 shows the measurement antenna mounted on the tripod on the flying bridge.

4.2.3 Radar Platform Location

The radar platform is a possible location for the L-band terminal antenna. Measurements were made with the log-spiral conical antenna attached to a boom which was cantilevered out 1.2 meters aft of the platform and pointed to look at the radars as shown in Photo 4.2-3. For a second set of measurements, the boom was moved to a position 1.2 meters off the starboard edge of the platform and again pointed toward the radars as shown in Photo 4.2-4. A 15-meter-length of RG-214/U coaxial transmission line cable was used to connect the antenna to the field intensity meter located in the wheelhouse, as shown in Photo 4.2-5.

4.2.4 Conduct of Tests

Measurements were made with the NM-65T which was calibrated at 40 dB at 1 GHz. With this procedure it is necessary to make an adjustment in the data to compensate for the non-linearity of gain and of the calibration generator. Chart B-1 gives the adjustment factor curve to convert the data to field intensity where the horn antenna was used in the storage room.

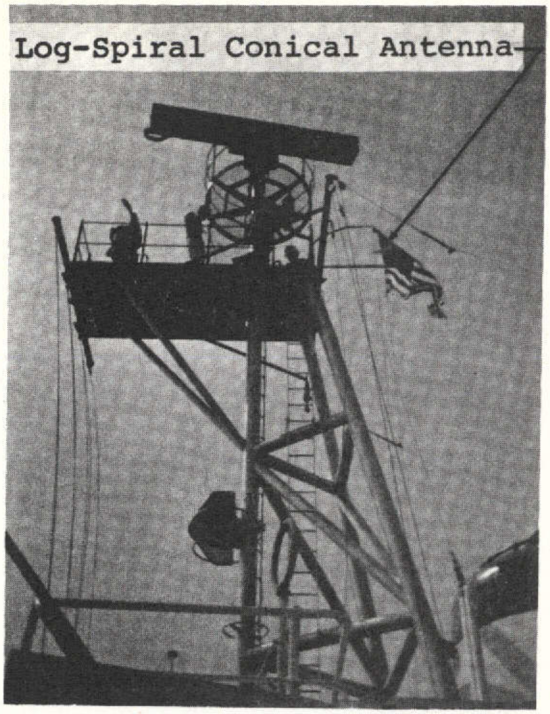


Photo 4.2-3, Field Intensity Measurement at Aft Position on Radar Platform

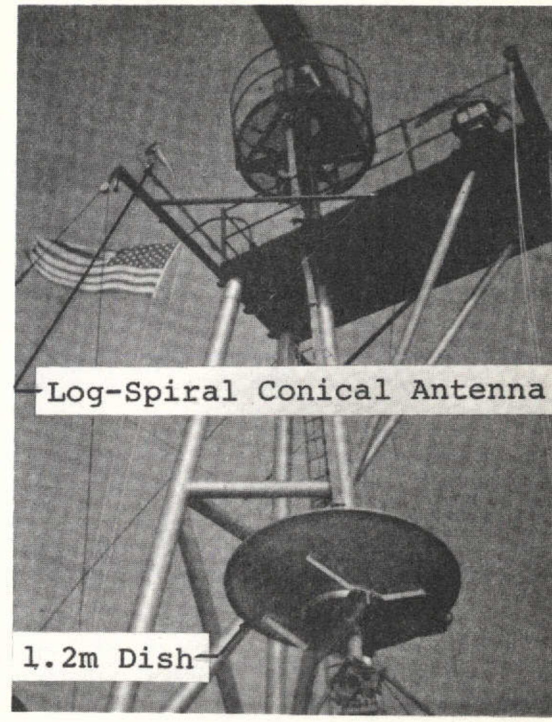


Photo 4.2-4, Field Intensity Measurement at Starboard Position on Radar Platform

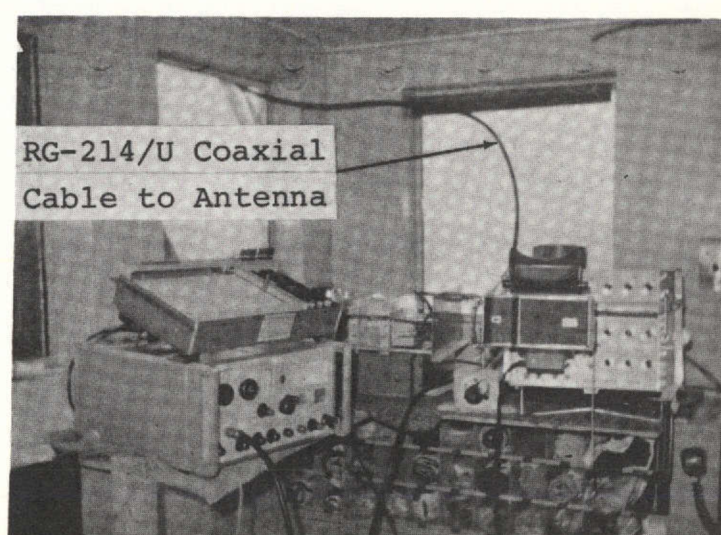


Photo 4.2-5, Instrument Setup in Wheelhouse for Field Intensity Measurement

Chart B-2 gives the adjustment factor curve to convert the data to field intensity where the log-spiral conical antenna was used. One curve applies to the storage room measurements where 3 meters of RG-9/U cable was used and the other curve applies to the radar mast measurements made using 15 meters of RG-214/U cable. Measurements on the starboard side of the flying bridge were made using the 12-meter-length of low-loss foam wellflex cable. The loss of this cable is within 1 dB of the loss of the 3 meter length of RG-9/U cable so the same antenna factor adjustment will be used for both of these cables. On each of these charts the ordinate scale on the left side is used to convert the meter reading to narrowband field intensity in dB/μv/m and the ordinate scale on the right side is used with the direct peak (DP) meter reading to convert to broadband field intensity in dB/μv/m/MHz.

4.2.5 Comments

Charts B-3 and B-4 were made with the antenna in front of the S-band radar with the radar off. Chart B-3 shows a signal at the S-band radar frequency. This is case radiation with the radar in standby mode. These should be compared with Charts B-5 and B-6, which were made with the radar on, where all the harmonics and spurious outputs clutter up the spectrum. The effect of the X-band radar is shown on Charts B-7 and B-8.

Chart B-9 shows the field intensity, at the starboard position on the flying bridge while the ship was in the Savannah harbor. The signal at 1.16 GHz, unidentified, was probably a radar at the nearby airbase or airport. The S-band radar signal, 91 dB/μv indicated on the meter, is 125.5* dB/μv/m/MHz and the

*The meter reading of 91 dB/μv is adjusted by the antenna factor, cable loss, and bandwidth factor plotted on Chart B-2. At 3050 MHz, the S-band radar frequency, this adjustment factor is 34.5 dB when the 12 m Foam Wellflex cable is used. 91+34.5 = 125.5 (dB/μv/m/MHz)

X-band radar, 84 dB/μv indicated on the meter, is 125* dB/μv/m/MHz. Charts B-10 and B-11 were made to show field intensity at the radar platform level; aft and starboard sides respectively.

A summary of the broadband field intensity levels is given in Table B-1 below.

Table B-1

Broadband Field Intensity Levels in dB/μv/m/MHz at Selected Locations

Location	1535-1660 MHz In-Band	3.1 GHz S-Band	9.5 GHz X-Band
Storage Room			
1m from S-band radar	77.5	104.5	
1m from X-band radar	51		115
Flying Bridge			
Starboard Side	35	125.5	125
Radar Mast			
Aft	53.5	136.5	162
Starboard	52.5	131.5	157

Charts B-12 through B-15 were recorded in the Philadelphia harbor area on the Delaware River. Chart B-12 was made at 0930 hours while the antenna was directed toward the Ben Franklin Bridge, a major traffic artery, about 4 kilometers distant. Beyond the bridge the Philadelphia Naval Base is 12 kilometers distant and the Philadelphia International Airport is 16 kilometers distant. Charts B-13 and B-14 were taken with the antenna looking toward the downtown Philadelphia area. Chart B-15 was made as the ship was underway in the river and approaching the Ben Franklin bridge at a distance of 0.8 kilometers. Automobile and truck traffic on the bridge was normal for this time of day (1509 hours) and there was no indication of ignition interference

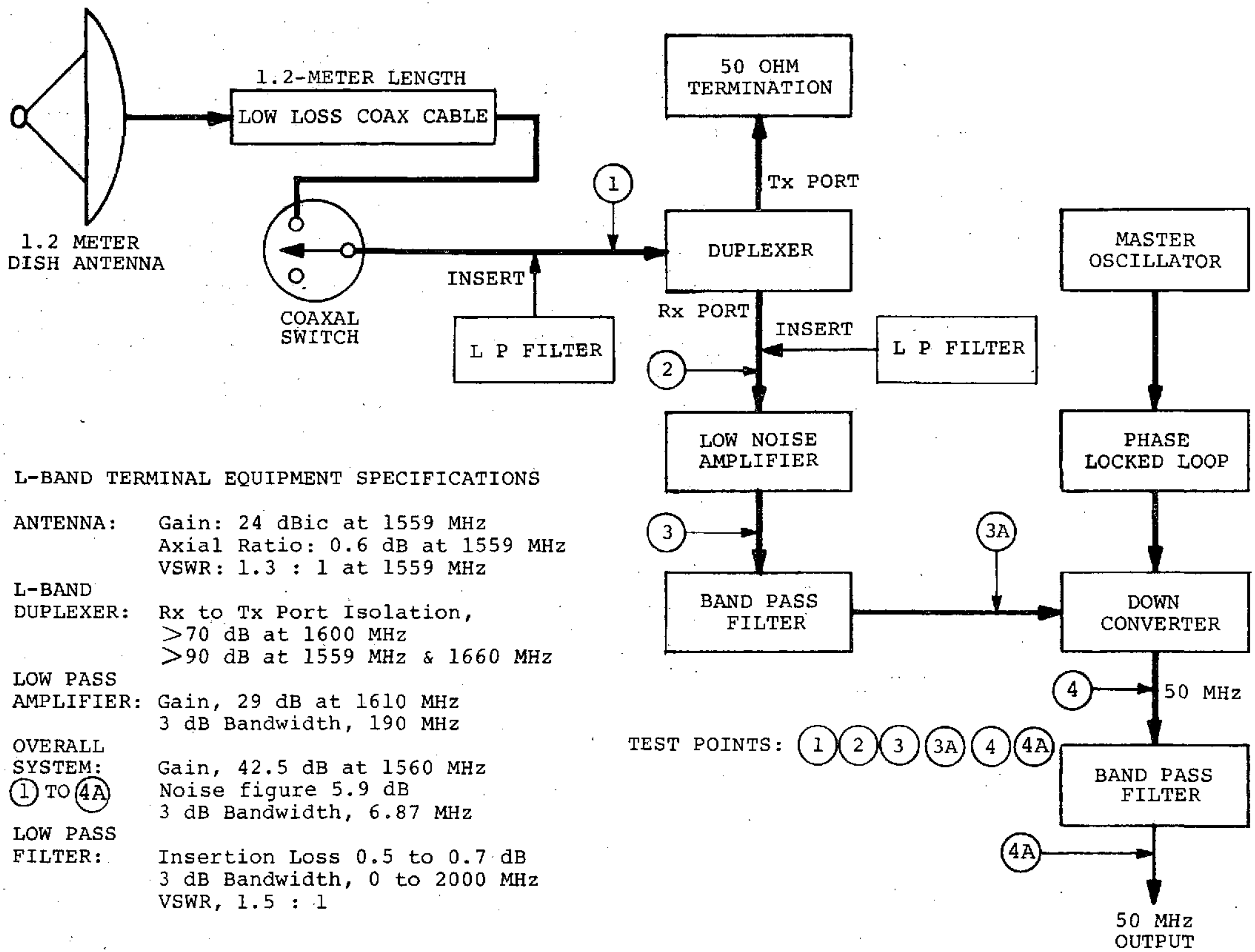
*The meter reading of 84 dB/μv is adjusted by the antenna factor, cable loss, and bandwidth factor plotted on Chart B-2. At 9375 MHz, the X-band radar frequency, this adjustment factor is 41 dB when the 12 m Foam Wellflex cable is used. 84+41 = 125 (dB/μv/m/MHz) in the 1.3 to 1.9 GHz band. Even as the ship came closer to the bridge and passed under it there was no evidence on the meter or in the monitor headphones of impulsive type emissions.

4.3 Filter Evaluation

The purpose of this test was to evaluate the performance of the L-band shipboard terminal when low pass filters were inserted between various elements to provide additional protection from interference and to reduce L-band terminal interference to on-board radars.

The measurements were made with the 1.2 meter dish antenna mounted on the tripod which in turn was mounted on the metal stand on the starboard side of flying bridge deck. The antenna was pointed in the direction of the 3 cm and 10 cm (S- and X-band) wavelength radar antennas. The radar antennas were stopped from rotation and directed toward the L-band terminal antenna. Instrumentation was located in the wheelhouse as shown in Photo 4.3-1 and the 12-meter length of low-loss coaxial cable was used to connect the antenna to the EMI instrumentation located in the wheelhouse. A Hewlett-Packard Spectrum Analyzer and a Singer Stoddart NM-65T Radio Interference Analyzer were used to record data. Spectrum analyzer data was taken with a Polaroid camera while the radio interference analyzer data was taken with an X-Y recorder.

The L-band terminal is shown in block diagram form in Figure 4.3-1 with test points indicated. Low-pass (LP) filters are also shown with the point of insertion marked.



L-BAND TERMINAL EQUIPMENT SPECIFICATIONS

ANTENNA: Gain: 24 dBic at 1559 MHz
Axial Ratio: 0.6 dB at 1559 MHz
VSWR: 1.3 : 1 at 1559 MHz

L-BAND DUPLEXER: Rx to Tx Port Isolation,
>70 dB at 1600 MHz
>90 dB at 1559 MHz & 1660 MHz

LOW PASS AMPLIFIER: Gain, 29 dB at 1610 MHz
3 dB Bandwidth, 190 MHz

OVERALL SYSTEM: 1 TO 4A Gain, 42.5 dB at 1560 MHz
Noise figure 5.9 dB
3 dB Bandwidth, 6.87 MHz

LOW PASS FILTER: Insertion Loss 0.5 to 0.7 dB
3 dB Bandwidth, 0 to 2000 MHz
VSWR, 1.5 : 1

FIGURE 4.3-1 L-BAND SYSTEM

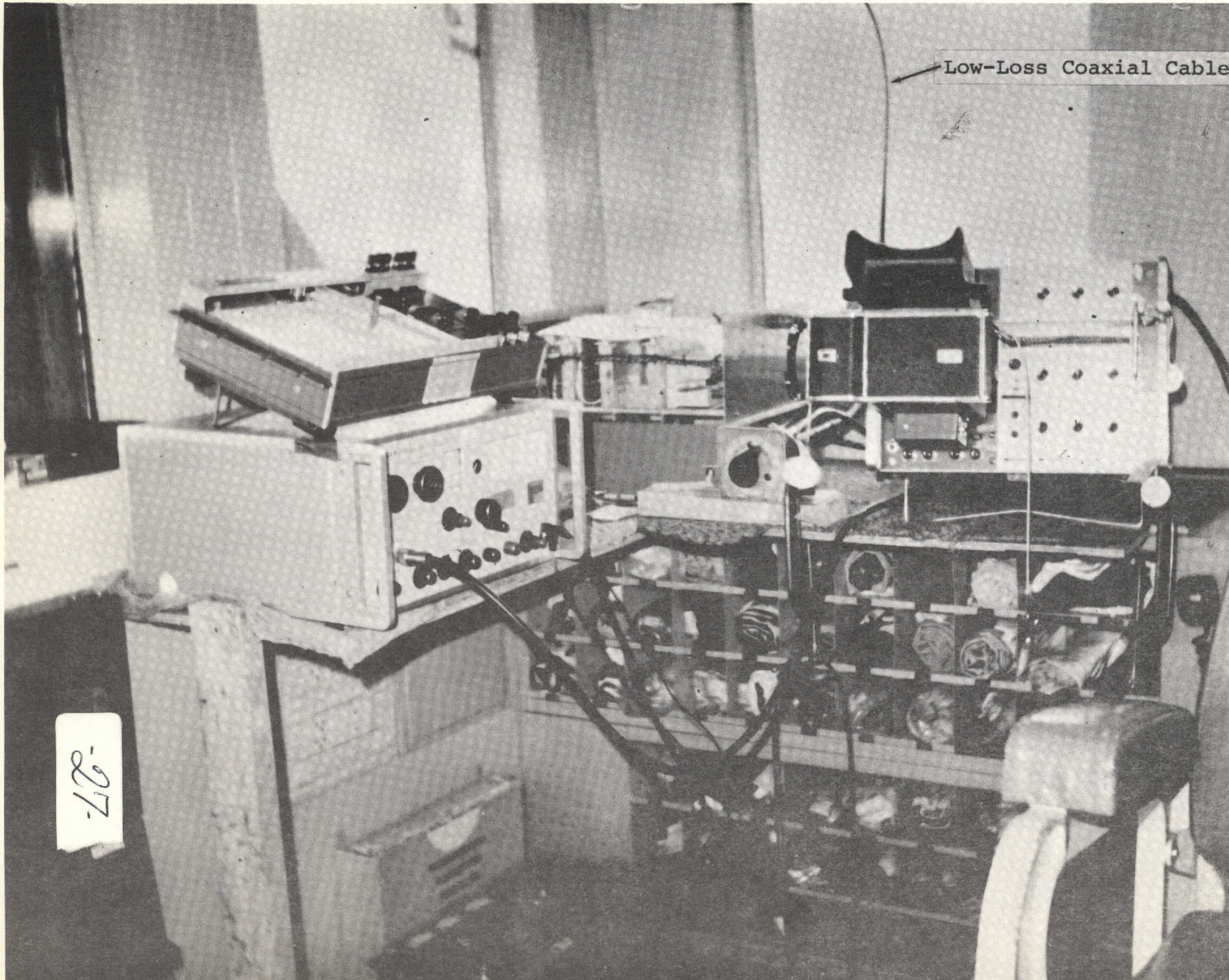


Photo 4.3-1 Instrumentation Setup in Wheelhouse for Filter Evaluation

4.3.1 Conduct of Test

The first measurements were made with the radars turned off and with the LP filters removed from the circuit. X-Y charts made under this condition show the ambient electromagnetic level in the Philadelphia harbor on the evening of June 17th as compared with the morning of June 18th in the harbor and again at sea on June 19th. A second set of measurements was made with the radars turned on while the measuring sets were connected to each test point in turn. It had been planned to insert an LP filter between the antenna and duplexer and between the duplexer and low noise amplifier in the receiving system. When the tests showed that only signals in the receive passband were getting through the duplexer, the second LP filter test was cancelled. It was also planned to insert a LP filter between the duplexer transmitter port and a power oscillator to investigate its effect on interference to the two radar sets. Since there was no interference to the radars without the filter it was not possible to test the effect of the filter in this position.

4.3.2 Analysis of Data

The X-Y charts are printed with a dB scale which is directly related to the meter scale of the Singer Stoddart NM-65T. The NM-65T was calibrated at 1 GHz at 40 dB. Since neither the gain of the NM-65T nor the output of the calibration generator is flat across the 1 to 10 GHz band it is necessary to make an adjustment which varies across the band, to convert the data to dB above 1 μv at the input terminals of the NM-65T. The correction factors for the direct peak (DP) and field intensity (FI) functions are shown on an adjustment Chart C-23. This includes a factor of

14 dB to adjust from a receiver bandwidth of 5 MHz used for all of the measurements. By using an adjustment factor found on this chart it is possible to convert any data information taken from a chart into dB relative to one microvolt for the field intensity (FI) function or dB relative to one microvolt per megahertz for the direct peak (DP) function.

The data shown on the spectrum analyzer photographs can be read in relative amplitude directly from the photograph. The legend with each photograph notes operating parameters such as bandwidth, scan width and the reference level which is the top line on the grid. The scale is 10 dB per division. To convert to broadband voltage levels for impulsive signals, an adjustment of +20 dB must be made to convert from the 100 kHz to 1 MHz bandwidth. For example, an impulsive noise which shows a level of -60 dBm (47 db/μv) on the spectrum analyzer display should be read as 67 dB/μv/MHz.

4.3.3 Comments

The X-Y charts were made by tuning the NM-65T across either the 1.3 to 1.9 GHz band or across the three bands that range from 1 to 10 GHz. The direct peak (DP) detector function was used for one scan trace and the field intensity (FI) for a second scan trace. The DP trace is easily identified by its irregularity consisting of short horizontal and vertical lines. These are a result of the circuit action in sampling the signal, holding, and dumping. This gives a response based on peak value and it is calibrated in RMS of an equivalent sine wave. A dump time of 0.3 seconds was selected. The field intensity (FI) function gives a smooth trace indicating the average value of the signal. This is suitable for the measurement of narrowband or CW signals. The identification "field intensity" is misleading when the instrument is used as a two terminal voltmeter to measure signal levels that are not converted to field intensity.

The discussion which follows is related to the X-Y charts appearing in Appendix C. Charts C-1, C-2, and C-3 show signals that were found in the Philadelphia harbor at 2152 hours in the evening of June 17th and again at 0900 hours the following morning, June 18th, compared with midday at sea on June 19th, the following day. Chart C-4 shows the lack of in-band signals at sea. Charts C-5, C-6, and C-7 were made with the radar antennas rotating. It was evident that this procedure would not give consistent results because of the variation of signal as the NM-65T scans the band while antennas rotate so the antennas were stopped in a position facing the L-band antenna and the balance of the measurements were made in this condition. Charts C-8 and C-9 show the effectiveness of the filter between the antenna and the duplexer in reducing the signal from the radars. At test point 2 the radar signal has been filtered out and the insertion of the LP filter between the duplexer and the low-noise amplifier produces no noticeable effect as shown in Charts C-10, C-11, C-12, C-13, and C-14. Unidentified signals were found at test point 3. To allay the possibility that these were generated in the low noise amplifier, a spare amplifier-serial no. 010, was substituted for the original amplifier, serial no. 001. The chart record was unchanged and it was surmised that the spurious signals were coming from the down converter feeding forward. The results of this test are shown on Charts C-15 through C-21. Chart C-22 was made to determine if the S-band radar would produce any in-band signal at the transmitter part of the duplexer.

4.4 Antenna Sky-Noise Temperature Measurements

Antenna sky-noise temperature measurements were made using parts of the L-band terminal and an AIL Type 2392B Radiometer as a noise power measuring device. The antenna-noise temperature measurement, T_A, is referenced to the antenna output terminals at 1559 MHz. Figure 4.4-1 is a block diagram showing the arrangement of the system elements for this measurement. The 1.2-meter parabolic reflector antenna was mounted on a TACO tripod which could be manually adjusted in elevation angle and azimuth to predetermined positions. The tripod was mounted on a metal stand so that the top of the tripod was 2.8 meters above the deck. The metal stand, tripod, and antenna are shown in Photo 4.4-1 as installed on the flying bridge deck, starboard side. A 12-meter, low-loss coaxial cable connected the antenna through a coaxial switch to the instrumentation located in the wheelhouse below the flying bridge. Photo 4.4-2 shows the instrumentation positioned on a shelf above the flag storage locker. The white container on the left is a styrofoam cup containing the cold reference load. The cup was kept filled with liquid nitrogen to establish a reference temperature of 77.35 degrees Kelvin (°K). This was calibrated to be 80°K at the end of the 10-cm long transmission line which extended through the cup. The coaxial switch was used to alternately connect the antenna or the cold reference load to the L-band system and radiometer. An X-Y recorder was used as the readout for the radiometer. Each measurement was made by adjusting the variable attenuator in the cold reference load line so that the

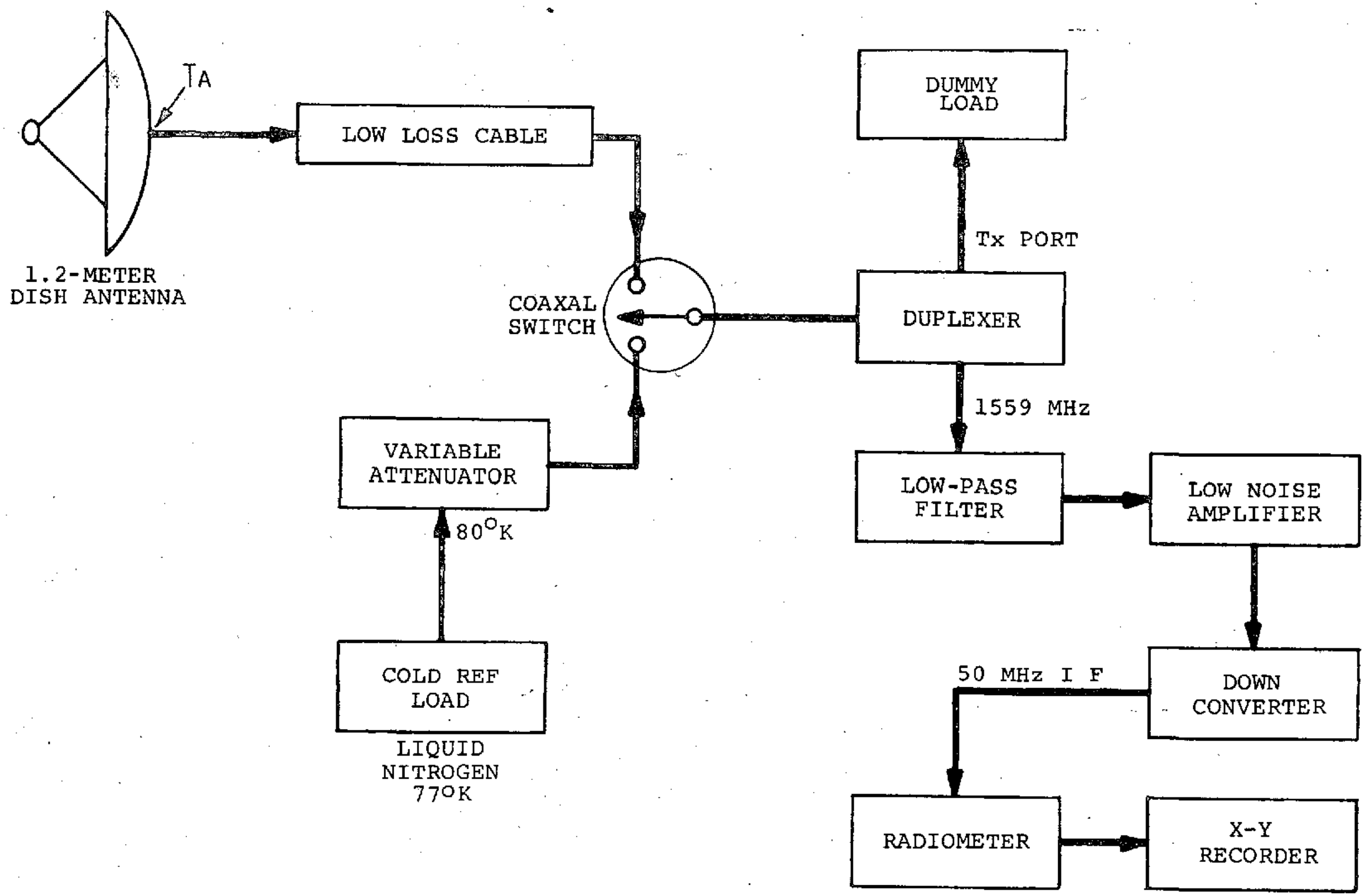


Figure 4.4-1
Radiometer Instrumentation for Antenna Sky-Noise Measurement
at 1559 MHz

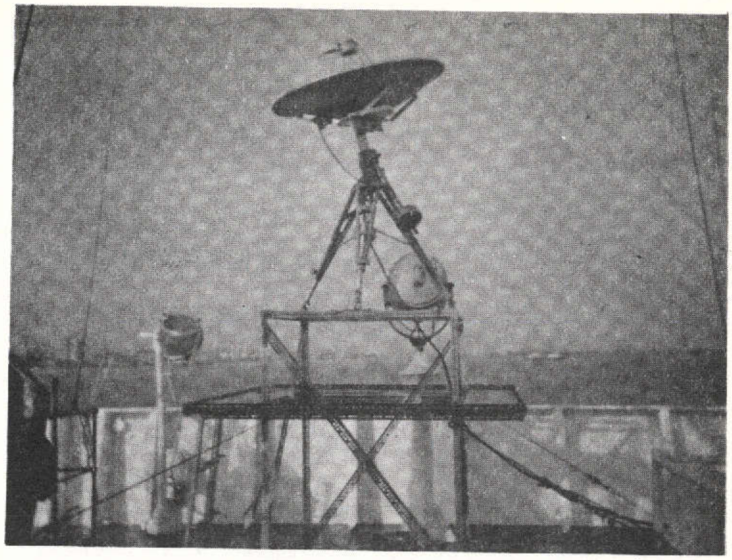


Photo 4.4-1, 1.2 Meter Diameter L-Band Dish Antenna Mounted on Tripod and Stand on Starboard Side of Flying Bridge

Photo 4.4-2, Instrumentation Setup in Wheelhouse for Antenna Sky-Noise Temperature Measurements

X-Y recorder readout was unchanged as the coaxial switch was switched from the antenna to the cold reference load.

4.4.1 Location of Measurements

Two sets of measurements were made, one designated "in-harbor" and the other "at-sea". The in-harbor measurements were started on June 16th while the ship was in-harbor at Port Elizabeth and concluded on June 18th while the ship was at the Tioga Terminal in Philadelphia. The at-sea measurements were started on June 17th while the ship was off the coast of New Jersey bound for Philadelphia and concluded on June 19th while the ship was underway from Philadelphia to Savannah.

The tripod with its azimuth scale was mounted on the platform in such a manner that when the antenna was pointed directly forward on the ship the azimuth scale read 288°. All of the data was recorded using this azimuth bearing. Consequently, the data shown in Tables D-1 and D-2 is referenced to a 0° which is 72° off the starboard bow. In the plots of the data shown in Figs. 4.4-3 and 4.4-4 an adjustment has been made to locate the bow of the ship at 0°. This also applies to Fig. 4.4-5 showing the relative location of ship structures.

4.4.2 Reduction of Data

To reduce the data to units of noise temperature the variable attenuator was calibrated at 1559 MHz using a Hewlett-Packard model 614A signal generator and Hewlett-Packard model 431B power meter. This calibration was again confirmed using a Hewlett-Packard 8614A signal generator and a Hewlett-Packard 432A power meter. The 12-meter, low-loss coaxial cable was measured at 1559 MHz using a Hewlett-Packard model 8410S network analyzer.

ANGLE	ELEVATION ANGLE													
Az	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	55°	65°	75°	85°
0°	184	13	37	28	46	49	46	188	40	25	49			43
20°	139	10	37	28	52	46	46	55	28	34	43			
40°	151	16	37	28	79	61	58	37	43	31	37	37	43	
60°	148	34	34	28	142	139	97	37	46	31	46			
80°	103	13	34	28	124	139	100	31	37	31	43			
100°	130	4	37	37	85	85	58	43	64	37	37	34	37	43
120°	107	64	46	49	70	76	58	40	49	37	40			
140°	101	76	82	58	82	61	58	55	52	46	52			
160°	103	103	85	76	82	73	76	85	70	67	61	85	76	
180°	220	37	55	52	79	112	106	97	70	85	94			43
200°	103	61	37	37	46	127	40	43	37	55	94			
220°	184	64	46	37	34	118	31	52	40	55	82	122	52	
240°	184	64	64	42	58	37	52	262	211	397	52	133		
260°	178	49	49	52	46	37	43	214	37	31	76			
280°	178	46	49	46	40	43	49	52	37	31	58	43	43	43
300°	142	37	49	43	40	43	43	97	43	31	85			
320°	166	13	49	37	49	37	37	169	49	31	58			
340°	190	55	37	28	55	49	46	205	40	31	76	37	43	

TABLE D-1

IN-HARBOR ANTENNA SKY-NOISE TEMPERATURE MEASUREMENTS, T_A, IN DEGREES KELVIN, °K, AT 1559MHz

ANGLE	ELEVATION ANGLE													
Az	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	55°	65°	75°	85°
0°	115	70	37	46	31	31	28	25	25	25	25			37
20°	151	76	34	43	37	31	31	28	25	28	31	31		
40°	136	76	49	46	37	34	31	31	25	28	31		34	
60°	139	76	52	55	34	31	34	31	31	31	31	22		
80°	130	67	37	49	34	31	31	31	31	31	31			
100°	88	61	37	22	37	34	31	25	25	31	31	34	34	34
120°	61	43	34	37	34	19	34	31	25	31	31			
140°	49	58	61	61	25	46	43	40	37	31	31	43		
160°	76	64	58	67	31	46	58	49	58	49	49		49	
180°	76	58	37	58	67	76	73	70	58	58	64	85		46
200°	88	43	22	46	49	43	37	34	31	37	67			
220°	76	43	13	46	43	37	34	28	31	37	67	97	157	
240°	85	43	25	43	28	34	31	25	17	31	67			
260°	70	46	34	43	25	31	25	25	25	25	28	34		
280°	73	49	25	43	34	31	25	25	25	28	25		34	43
300°	85	58	31	43	31	25	25	25	28	25	25	43		
320°	100	58	31	46	28	28	25	25	19	25	25			
340°	115	67	31	46	37	31	31	28	25	31	25	31	34	

TABLE D-2

AT-SEA ANTENNA SKY-NOISE TEMPERATURE MEASUREMENTS, T_A, IN DEGREES KELVIN, °K, AT 1559MHz

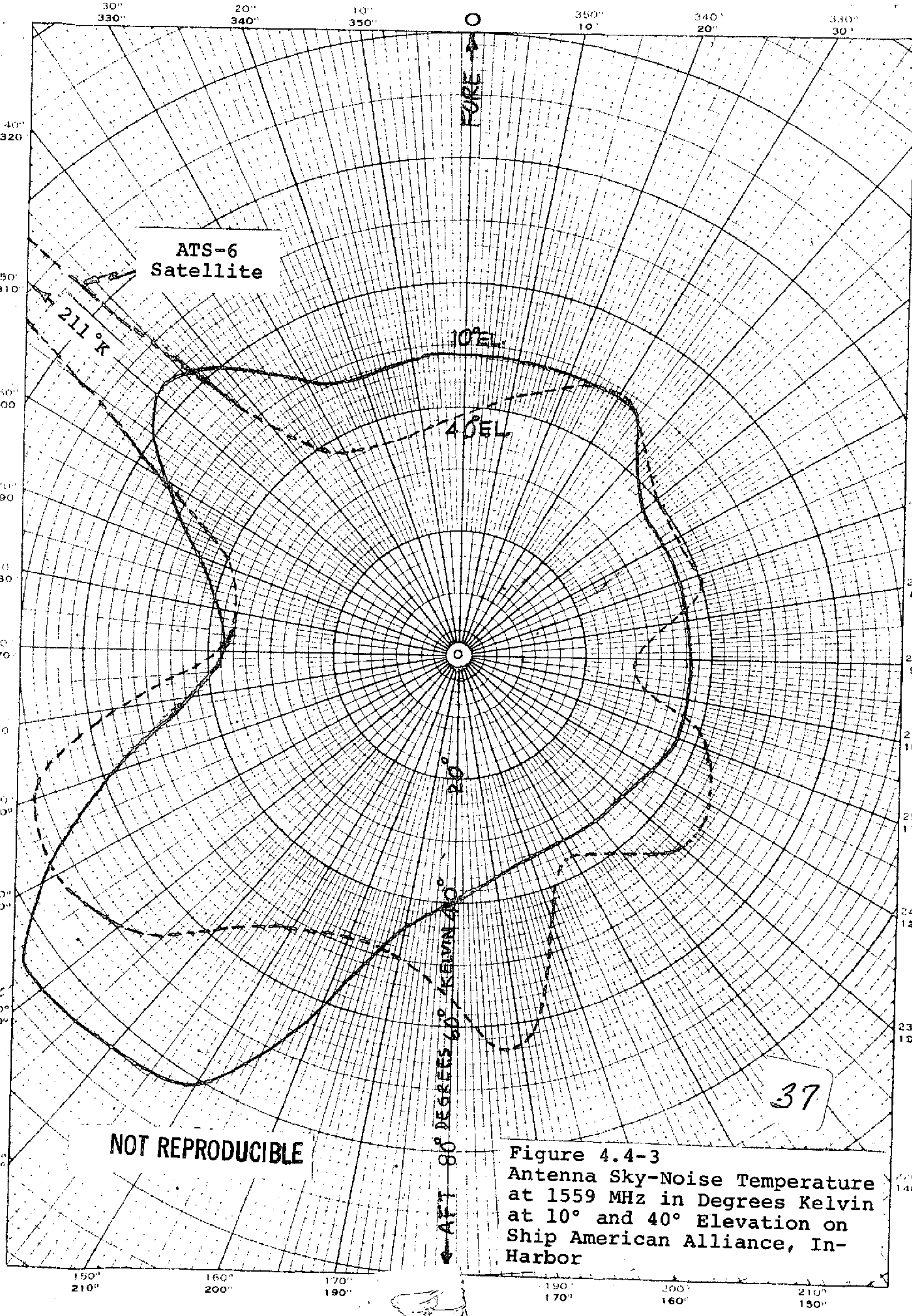


Figure 4.4-3
Antenna Sky-Noise Temperature at 1559 MHz in Degrees Kelvin at 10° and 40° Elevation on Ship American Alliance, In-Harbor

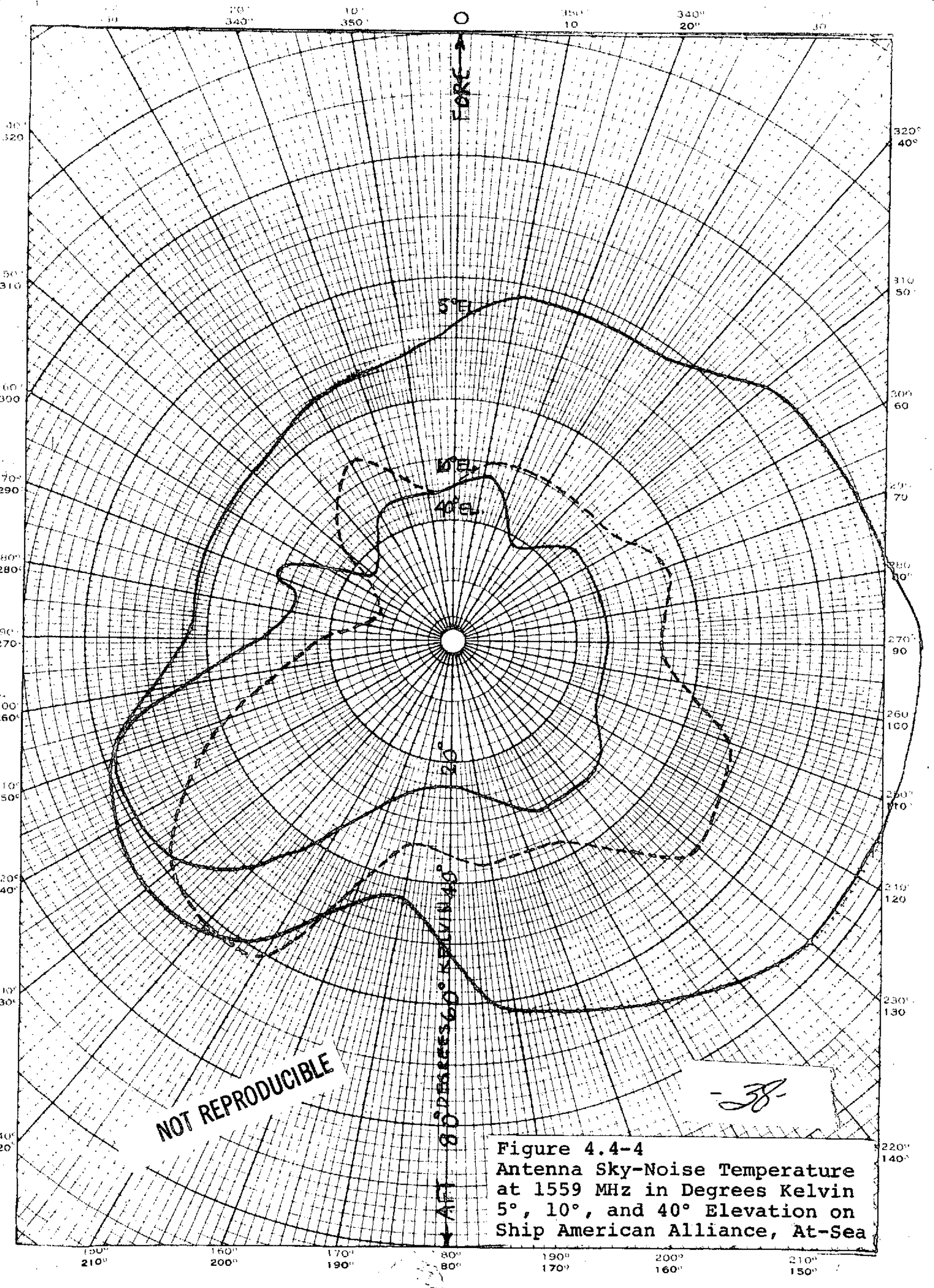


Figure 4.4-4
Antenna Sky-Noise Temperature
at 1559 MHz in Degrees Kelvin
5°, 10°, and 40° Elevation on
Ship American Alliance, At-Sea

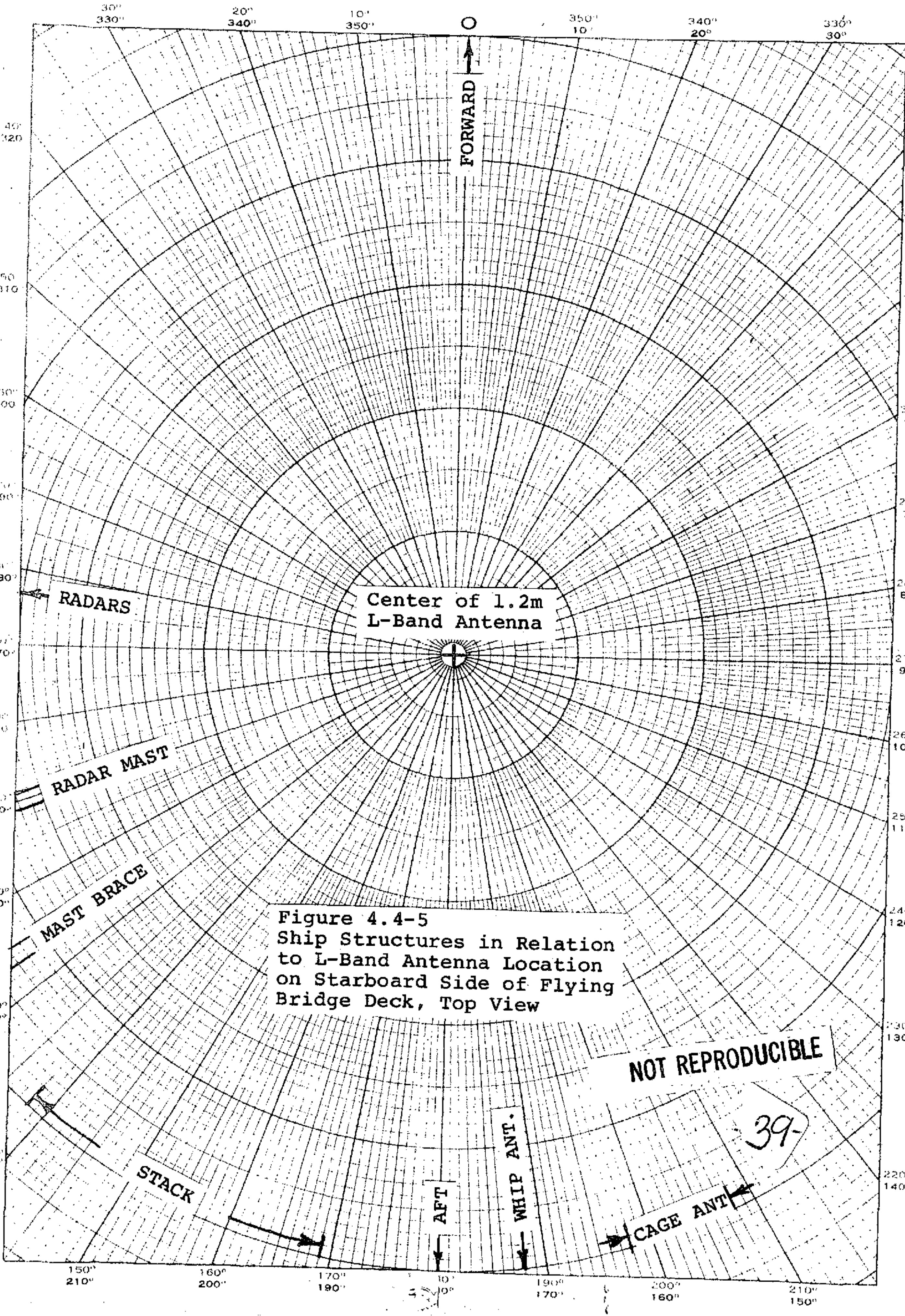


Figure 4.4-5
Ship Structures in Relation to L-Band Antenna Location on Starboard Side of Flying Bridge Deck, Top View

NOT REPRODUCIBLE

39

The shorter cables were measured with the same instrumentation used to calibrate the variable attenuator. Cable and attenuator loss was converted to temperature difference using the equations:

$$T_A = T_\alpha + 80 - 154$$

$$T_A = T_\alpha - 74$$

where, $T_\alpha = (10^{\alpha/10} - 1)\ 300$

where: T_α = noise temperature representing loss of attenuator and associated coaxial cable, °K

α = attenuation in decibels

T_A = antenna sky-noise temperature at 1.2 m dish antenna output terminals

154 = noise temperature representing loss in coaxial line to antenna, °K

300 = ambient temperature, °K

80 = cold load reference termperature, °K

Example:

where attenuator dial reads 22.5, attenuation is 0.9 dB (from the calibration curve, Fig. 4.4-2). The two short coaxial cables in the attenuator circuit add 0.7 dB for a total of 1.6 dB = α in the cold reference load circuit.

$$T_\alpha = (10^{\alpha/10}-1)\ 300$$

$$= (10^{.16}-1)\ 300$$

$$= (1.445-1)\ 300$$

$$= (0.445)\ 300$$

$$= 133.5$$

$$T_A = 133.5-74$$

$$= 59.5°K$$

4.4.3 Comments

While making the measurements on June 18th at the Tioga Terminal at Philadelphia it was noticed that the readings over Camden were much higher than over the surrounding area. It was suggested that the L-band 1.2 m dish antenna might be looking at the NASA ATS-5 or ATS-6 Applications Technology Satellites (ATS). Consequently, a check was made of the daily operations plan and it was found that ATS-6 was operating at L-band from 1000 to 1330 EDST. ATS-6 is positioned at 94° West Longitude within one degree of the equator. This would indicate a compass bearing of 208° East of North at the Tioga Terminal and this is in agreement with the observed bearing of approximately 209°. The calculated elevation angle was 40° and this is also in agreement with the high noise-temperature readings which were recorded at 35°, 40° and 45° elevation angle, referenced to the deck of the ship (Table D-1).

The measurement error of antenna noise-temperature will be influenced by factors such as (a) calibration error for the attenuator, (b) the error in reading the vernier scale on the attenuator and (c) the measurement error for cable loss of the coaxial cables interconnecting the antenna and the coaxial switch, the cold reference load and the variable attenuator, and the variable attenuator and the coxial switch. For example:

let $T_A = 50°K$

then $T_\alpha = 50+74 = 124$

so $1+(124/300) = \text{anti log } \alpha/10$

and $\alpha = 1.5$ dB

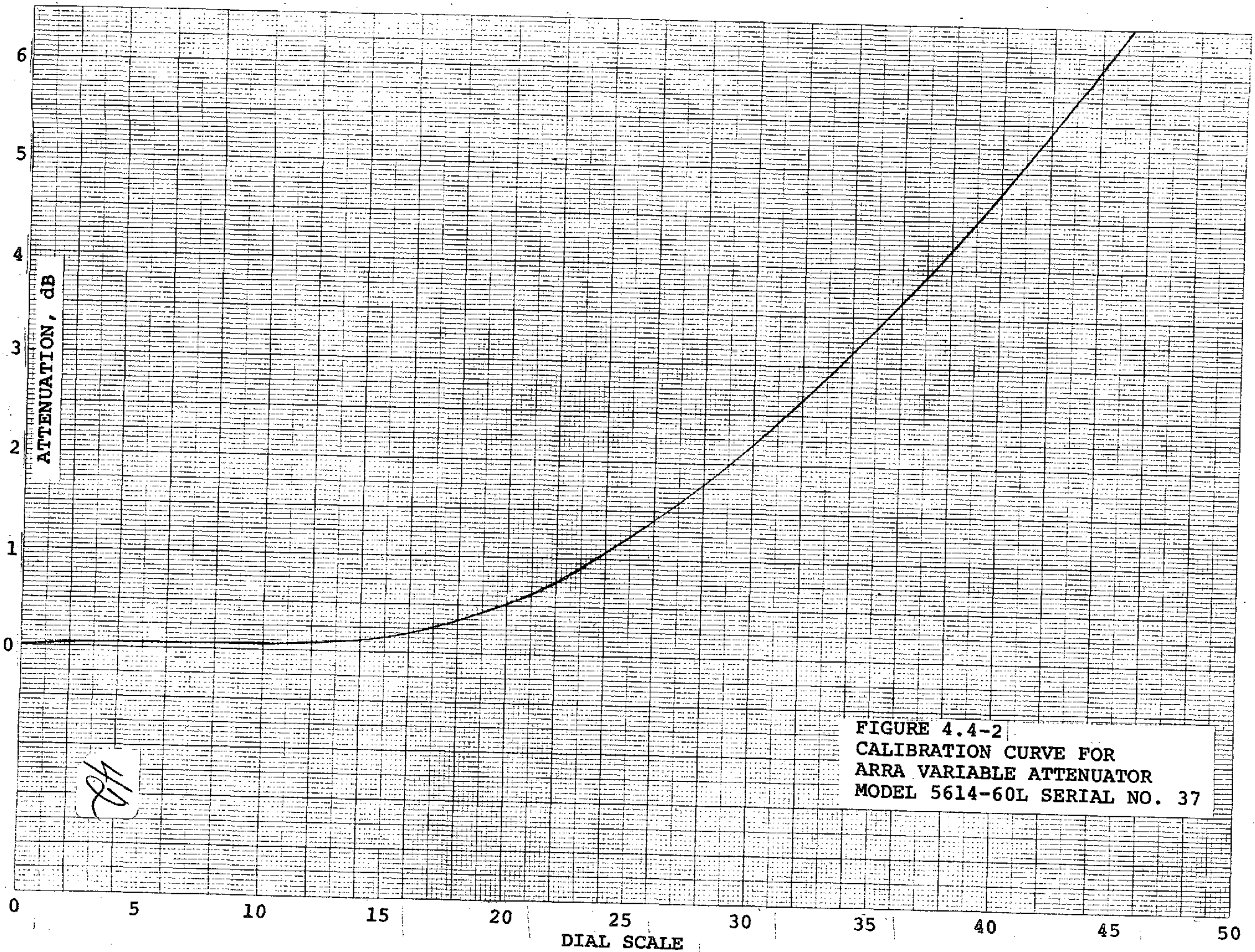


FIGURE 4.4-2
CALIBRATION CURVE FOR
ARRA VARIABLE ATTENUATOR
MODEL 5614-60L SERIAL NO. 37

Thus, the total attenuation between the cold load reference point and the coaxial switch is 1.5 dB. Part of this is attenuator loss and part is coaxial cable loss. Typically the cable loss is 0.6 dB leaving an attenuator loss of 0.9 dB. If the error in cable loss measurement is 0.1 dB the attenuation is 1.5 dB ± 0.1 dB. However, cable loss measurements should be accurate to within 0.1dB.

Let $\alpha = 1.5-0.1 = 1.4$ dB

$$T_\alpha = (10^{.14}-1)\ 300$$

$$T_\alpha = (1.380-1)\ 300$$

$$T_\alpha = 114$$

$$T_A = T_\alpha - 74$$

$$T_A = 40°K$$

Compare this with 50°K for 1.5 dB attenuation. Thus, an error of 0.1 dB in cable loss results in a change of 10°K in antenna noise-temperature at 50°K. An error in reading the variable attenuator by one division of the vernier scale represents approximately 0.0175 dB at 25 on the dial (less at lower dial readings).

Let $\alpha = 1.5-0.0175 = 1.4825$ dB

$$T_\alpha = (10^{.14825}-1)\ 300$$

$$T_\alpha = (1.407-1)\ 300$$

$$T_\alpha = 122.1$$

$$T_A = T_\alpha - 74$$

$$T_A = 48.1°K$$

Compare this with 50°K for 1.5 dB attenuation. Thus, an error in reading the attenuator of 0.1 division will result in an error of 1.9°K. The root-sum-square of these combined errors is 10.2° [illegible]. It is estimated that the overall accuracy of the antenna-noise temperature measurements are at least this good, or better.

The results of the measurements have been tabulated in Table D-1 for the in-harbor measurements and Table D-2 for the at-sea measurements. The measurements were influenced by ships structures such as the stack as well as by shore-based structures while the ship was in the harbor. Plots were made of the measurements at certain elevation angles both in-harbor and at-sea as shown in Figures 4.4-3 and 4.4-4. Figure 4.4-5 shows the relative position of certain structures on the ship in reference to the L-band terminal antenna position on the starboard side of the flying bridge deck.

4.5 Interference to Radar

The test of L-band interference to the radars was planned as a part of this survey. The radars were turned on and made operational while the L-band dish antenna was directed toward the radars and the radar display observed for evidence of interference. An AIL model 124 power oscillator was used as a substiture for the L-band transmitter. The L-band antenna had been set up on its tripod and stand on the starboard side of the flying bridge. This put the L-band antenna at a line-of-sight distance of approximately 7.4 meters from the X-band radar antenna and approximately 9.2 meters from the S-band radar antenna. Photo 4.5-1 shows these antennas.

4.5.1 Conduct of Test

The test was conducted while the ship was in the harbor at Port Elizabeth, New Jersey. Photo 4.5-2 shows a section of the wheelhouse with the two radar display and control units and a service cabinet between them. The S-band radar is on the left

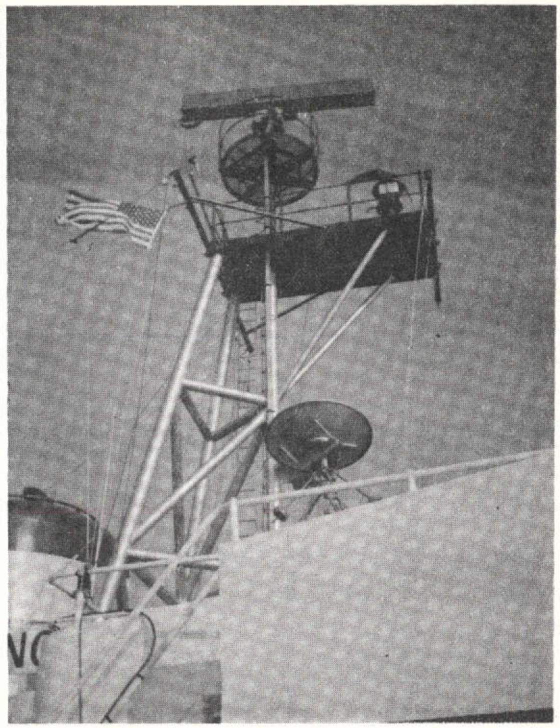


Photo 4.5-1, Radar Platform with
S-Band and X-Band
Radar Antennas.
L-Band 1.2 Meter
Dish Antenna Below
on Flying Bridge

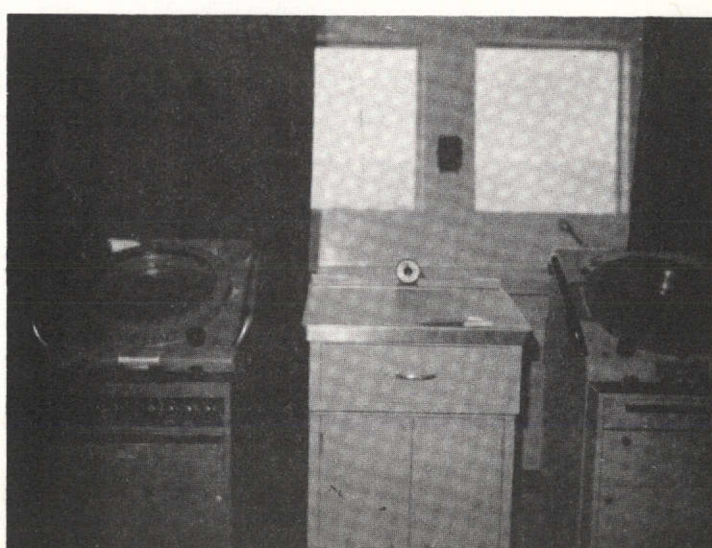


Photo 4.5-2, Radar Display
Units in Wheelhouse

and the X-band radar on the right. The trasmitter, receiver, and power supply for each radar is located in the storage room on the deck directly below the wheelhouse. A camera mounting bracket was installed in the ceiling directly above each radar so that a Polaroid camera could be used to photograph each display. Photos 4.5-3 and 4.5-4 show the radar displays before the L-band terminal was energized.

The L-band terminal was set up in another section of the wheelhouse and connected to the 1.2 meter L-band dish antenna on the flying bridge with a 12-meter-length of low-loss coaxial cable. An AIL power oscillator was connected to the transmitter port of the duplexer and tuned to 1659 MHz, the L-band up-link frequency. With the power oscillator adjusted to full output of 15 watts and the L-band antenna directed toward the radar antennas, a photograph was made of each radar display. There was no evidence of interference on either display as shown in Photos 4.5-5 and 4.5-6. To verify that the L-band signal was being radiated, the log-spiral conical antenna was set up on the flying bridge and connected to the H-P Spectrum Analyzer to sample the radiated signal.

4.5.2 Comments

In this test neither radar was equipped with waveguide filters which are available to control interference effects. The S-band radar was operating in the 1-nautical-mile range which selects a pulse duration of 0.1 microseconds and a pulse repetition rate of 2000. Average power output is 6 watts and the receiver bandwidth is 12 MHz. The X-band radar was also operating in the 1-nautical-mile range. The pulse duration is 0.25 microseconds

Photo 4.5-3, S-Band Radar Display with L-Band Transmitter Off, Port Elizabeth

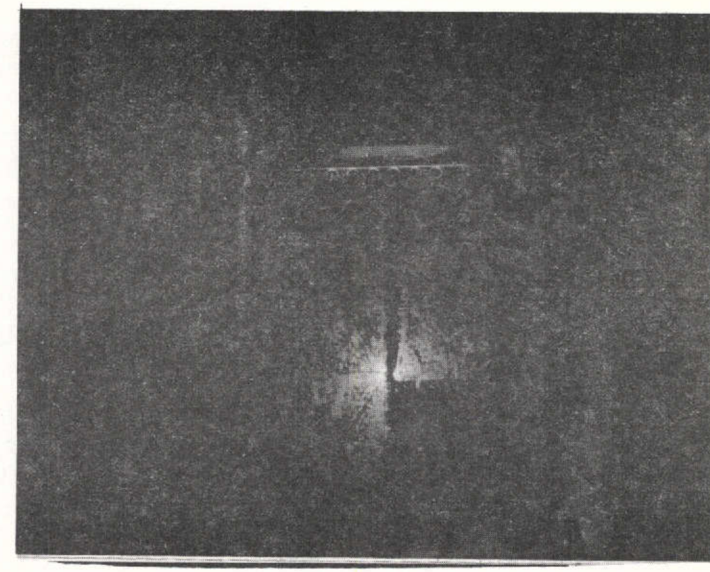


Photo 4.5-4, X-Band Radar Display with L-Band Transmitter Off, Port Elizabeth

Photo 4.5-5, S-Band Radar Display with L-Band Transmitter On, Port Elizabeth

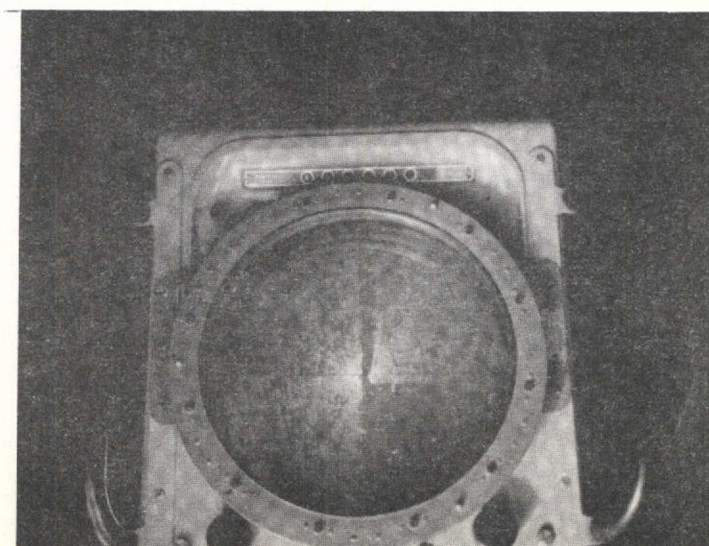


Photo 4.5-6, X-Band Radar Display with L-Band Transmitter On, Port Elizabeth

with a pulse repetition rate of 2000. The average power is 20 watts and the receiver bandwidth is 2.5 MHz. If the S-band radar were operated in the 6, 16, or 40-nautical-mile range, the average power would be increased to 12 watts and the receiver bandwidth reduced to 3 MHz. Each of these changes are in the direction of reducing potential interference and since the second harmonic of the L-band transmitter (3318 MHz) is sufficiently removed from the operating frequency of the S-band radar (3050 MHz), the possibility of interference is remote.

The X-band radar characteristics also change when it is operated in the 8, 20, or 40-nautical mile range. While the average power remains at 20 watts, the receiver bandwidth is increased to 8 MHz. This increase in bandwidth should not be significant in view of the frequency separation between the X-band radar operating frequency (9375 MHz) and the L-band terminal (1659 MHz), or even the sixth harmonic of the L-band terminal (9954 MHz).

5. Analysis of Results

5.1 Conducted Emissions

The conducted emissions measured on the ship's power lines at the terminals of the radar sets were in almost all cases higher than that measured on the commercial power lines in the RCA calibration laboratory. The comparison was made on an octave-by-octave basis over the frequency range of 150 kHz to 32 MHz. Narrowband and broadband emissions were on the order of 50 dB higher on the lower bands and about 15 dB higher on the upper bands. The broadband measurements on each shipboard power line exceeded the limits specified in MIL-STD-461A.

An examination of the charts shows many sharp peaks in the broadband measurements. Many of these were transients occurring on a time basis. Others were steady in the frequency spectrum. Some represented broadcast station signals in the broadcast band, 540 to 1600 kHz, and even foreign broadcast stations as noted on the charts.

The spectrum display pictures centered at 70 MHz show that the noise level at this frequency is 36 dB/μA/MHz which is well below the MIL-STD-461A limit extrapolated to 70 MHz. The level of conducted emissions existing on the power lines indicates that any sensitive equipment connected to the power lines should include a power line filter. The insertion loss of the filter would be determined by the sensitivity of the equipment.

5.2 Field Intensity

Measurements of field intensity one meter from the radar transmitter cabinets in the storage room showed that the cabinet radiation in the maritime L-band was not excessive and was reasonable when compared with MIL-STD-461A, Electromagnetic Interference Characteristics, Requirements for Equipment, which is a generally recognized standard for this type of equipment. While the limits of the standard do not exceed 1000 MHz for broadband interference, they can be extrapolated up to the X-band radar frequency range. This extrapolation would put the case radiation in S-band and X-band about 5 dB above the limit in each case. Equipment built to meet MIL-STD-461A requirements would withstand a radiated field intensity of 1 volt/meter which would be adequate protection under the circumstances.

Field intensity measurements at the above deck locations showed levels in the maritime L-band that were equivalent to or less than the levels measured in the storage room. The field intensity measurements in the S-band and X-band were, as expected, severe enough to require special attention to shielding requirements for equipment that might be installed in these locations, particularly on the radar platform where levels were greater than 10 v/m/MHz. On the flying bridge deck level the field intensity was 2 v/m/MHz.

5.3 Filter Evaluation

Measurements made at five different interfaces in the L-band shipboard terminal system indicated that additional low-pass filtering would not be required to prevent interference from the radars as installed on the "American Alliance". The combined filtering action of the duplexer, the LNA, and the installed filters so completely suppressed the radar signals that the addition of low-pass filters produced no discernable change at the output of the duplexer or any other interface downstream from this point.

Radar interference to the L-band shipboard terminal will be influenced by the relative location of the antennas. On the "American Alliance", the antenna separation from the L-band antenna to the S-band antenna was 9.2 meters and to the X-band antenna, 7.4 meters. Closer spacing might justify the requirement for an additional low-pass filter.

5.4 Antenna Sky-Noise Temperature

The in-harbor measurements were made in Port Elizabeth (0°, 5°, 10° and 15° elevation) and Tioga Terminal, Philadelphia (20°, to 90° elevation). In Port Elizabeth the ship was berthed on its port side while at Tioga Terminal it was berthed on its starboard side. This is significant in that the loading crane and other dockside structures which affect the antenna noise temperature change sides of the ship as the elevation angle changes from 15° to 20°.

While the measurements were being made at the Tioga Terminal, several very high readings were recorded at the 240° aximuth, the highest being at 45° elevation. It was later determined that the antenna was looking at the ATS-6 satellite.

Both in-harbor and at-sea the 0° elevation measurements were considerably higher than the 5° elevation measurements at the same azimuth direction. This was anticipated because of ship structure and noise sources on the horizon especially in-harbor.

At-sea the measurements on the starboard side are much higher than on the port side at 0° elevation. This is accounted for by the fact that the ship was proceding south, and shore based noise sources were off the starboard side of the ship.

5.5 Interference to Radars

The test for L-band shipboard terminal interference to the S-band and X-band radars as installed on the "American Alliance" showed that this should not be a problem with 15 watts power from the L-band transmitter. Without a higher power source being available, it was not possible to determine at what power interference would exist. It is also conceivable that a lesser separation between antennas and a more nearly beam-to-beam aspect could produce an interference situation.

APPENDIX A, CONDUCTED EMISSIONS

Chart A-1 to A-15, X-Band Radar, Black Line

Chart A-16 to A-30, X-Band Radar, White Line

Chart A-31 to A-41, S-Band Radar, T2 Terminal

Chart A-42 to A-52, RCAS Laboratory, Black Line

Chart A-53, Current Probe Calibration

Spectrum Display A-1, S-Band Radar, T_2 Terminal

Spectrum Display A-2, X-Band Radar, Black Line

Spectrum Display A-3, S-Band Radar, T_2 Terminal

Spectrum Display A-4, X-Band Radar, Black Line

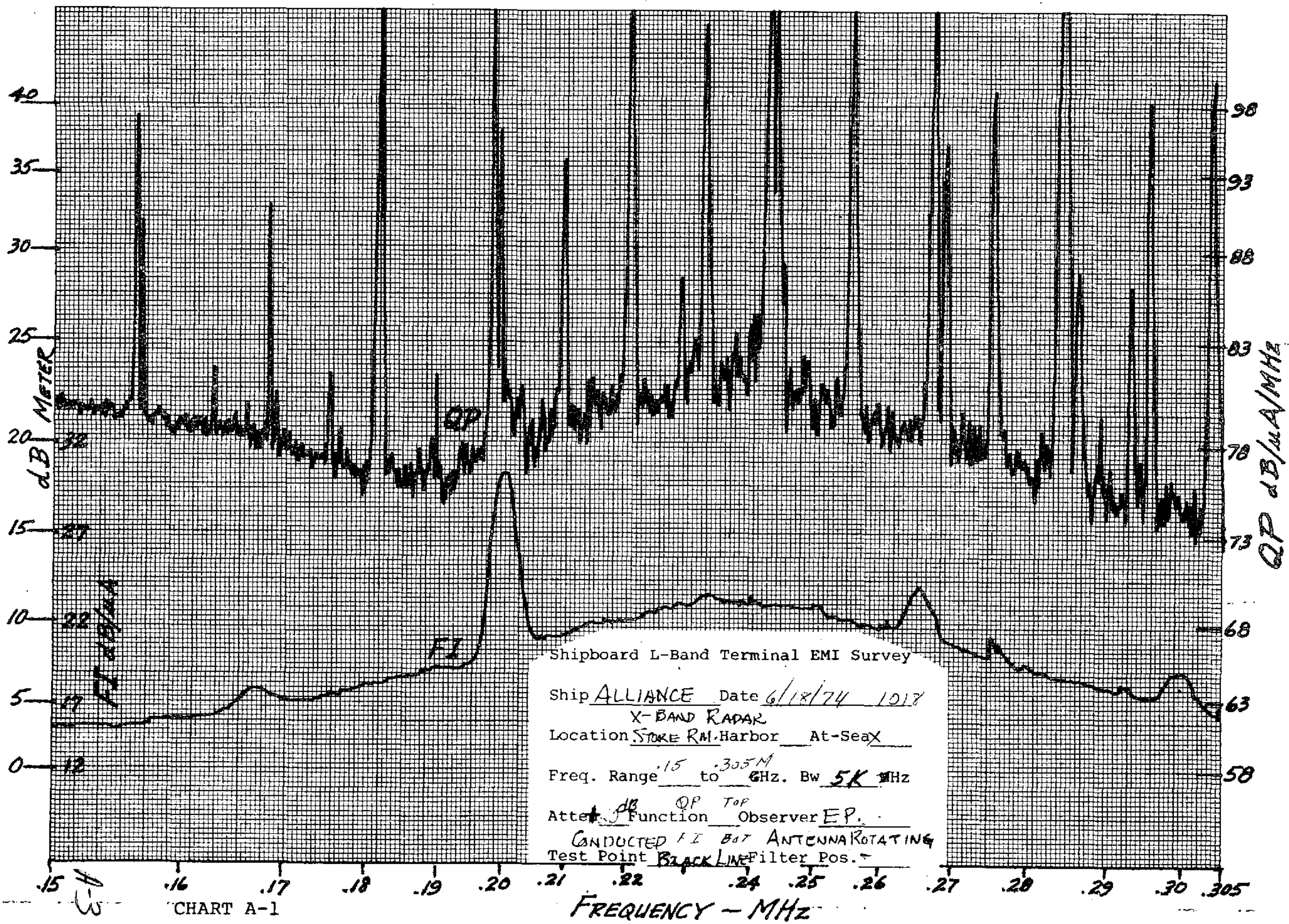
COMMENTS ON THE USE OF THESE CHARTS AND SPECTRUM DISPLAYS

Charts A-1 through A-52 bear vertical scales for signal amplitude. The scale in the left hand margin is calibrated in dB from the meter scale of the measuring instrument (Stoddart NM-25T). The scale just inside the left margin (on the grid) is calibrated in dB/μA to read narrowband signals using the Fl (Field Intensity) trace on the chart. The calibration of this scale includes adjustments for the attenuator loss and current probe transfer impedance. The scale in the right hand margin is calibrated in dB/μA/MHz to read broadband signals using the QP (Quasi Peak) trace on the chart. This calibration includes adjustments for the attenuator loss, current probe transfer impedance and instrument bandwidth. Attenuator loss is noted on the label on each chart. The current probe transfer impedance factor is taken from Chart A-53. The value for each frequency range is shown on the chart. It should be noted that while the transfer impedance values are positive they have been subtracted from signal amplitude in db/μv to convert to dB/μA. The bandwidth of the Stoddart NM-25T is 5 kHz. To convert the broadband readings to dB/μA/MHz a factor of 20 log $\frac{BW2}{BW1}$ has been added, where BW1 is the instrument bandwidth (5 kHz) and BW2 is the normalized bandwidth (1 MHz). This factor, 20 log $\frac{1\ MHz}{5\ kHz}$ is 46 dB.

Spectrum Displays A-1 through A-4 show signal levels in dBm as measured by the spectrum analyzer with the current probe. To convert these values to dB/μA it is necessary to use a transfer impedance value for the particular frequency of interest by reference to the current probe calibration, Chart A-53. At the same time the spectrum analyzer power level in dBm must be converted to voltage level in dB/μv by adding 107 dB. For example from Spectrum Display A-2 at 52 MHz the level is -82 dBm.

From spectrum analyzer	- 82 dBm
convert to μv	+107 dB
	+ 25 dB/μv
transfer impedance	(-)+ 15 dB/ohm
	+ 10 dB/μA

Thus 10 dB/μA is the peak value of the current in the X-band radar black power line at 52 MHz as measured with the spectrum analyzer with a bandwidth of 100 kHz. To normalize this to 1 MHz it is necessary to add 20 dB which is 20 log of the bandwidth ratio. This gives a value of 30 dB/μA/MHz.



dB METER
FI dB/uA
QP dB/uA/MHz
40
35
30
25
20
15
10
5
0
32
27
22
17
12
98
93
88
83
78
73
68
63
58
QP
FI
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1018
X-BAND RADAR
Location STORE RM. Harbor At-Sea X
Freq. Range .15 to .305M GHz. Bw 5K MHz
Atten 0 dB Function QP TOP Observer E.P.
CONDUCTED FI BOT ANTENNA ROTATING
Test Point BLACK LINE Filter Pos. -
.15
.16
.17
.18
.19
.20
.21
.22
.24
.25
.26
.27
.28
.29
.30
.305
FREQUENCY — MHz

CHART A-1

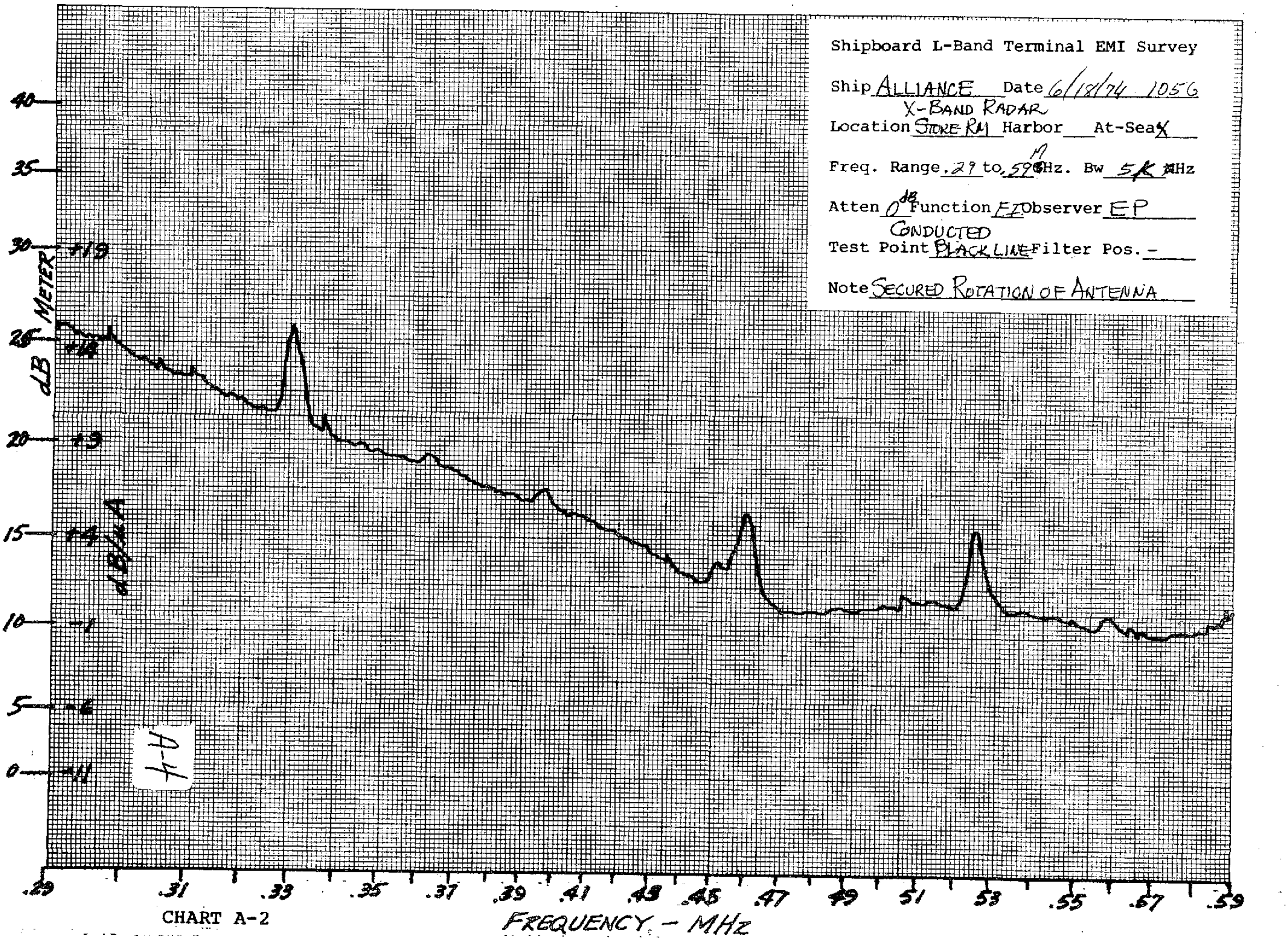

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1056
X-BAND RADAR
Location STORE RM Harbor At-Sea X
Freq. Range .29 to .59 MHz. Bw 5K Hz
Atten 0 dB Function EI Observer EP
CONDUCTED
Test Point BLACK LINE Filter Pos. -
Note SECURED ROTATION OF ANTENNA
dB METER
dB/μA
40
35
30 +19
25 +14
20 +9
15 +4
10 -1
5 -6
0 -11
A-4
.29
.31
.33
.35
.37
.39
.41
.43
.45
.47
.49
.51
.53
.55
.57
.59
FREQUENCY - MHz

CHART A-2

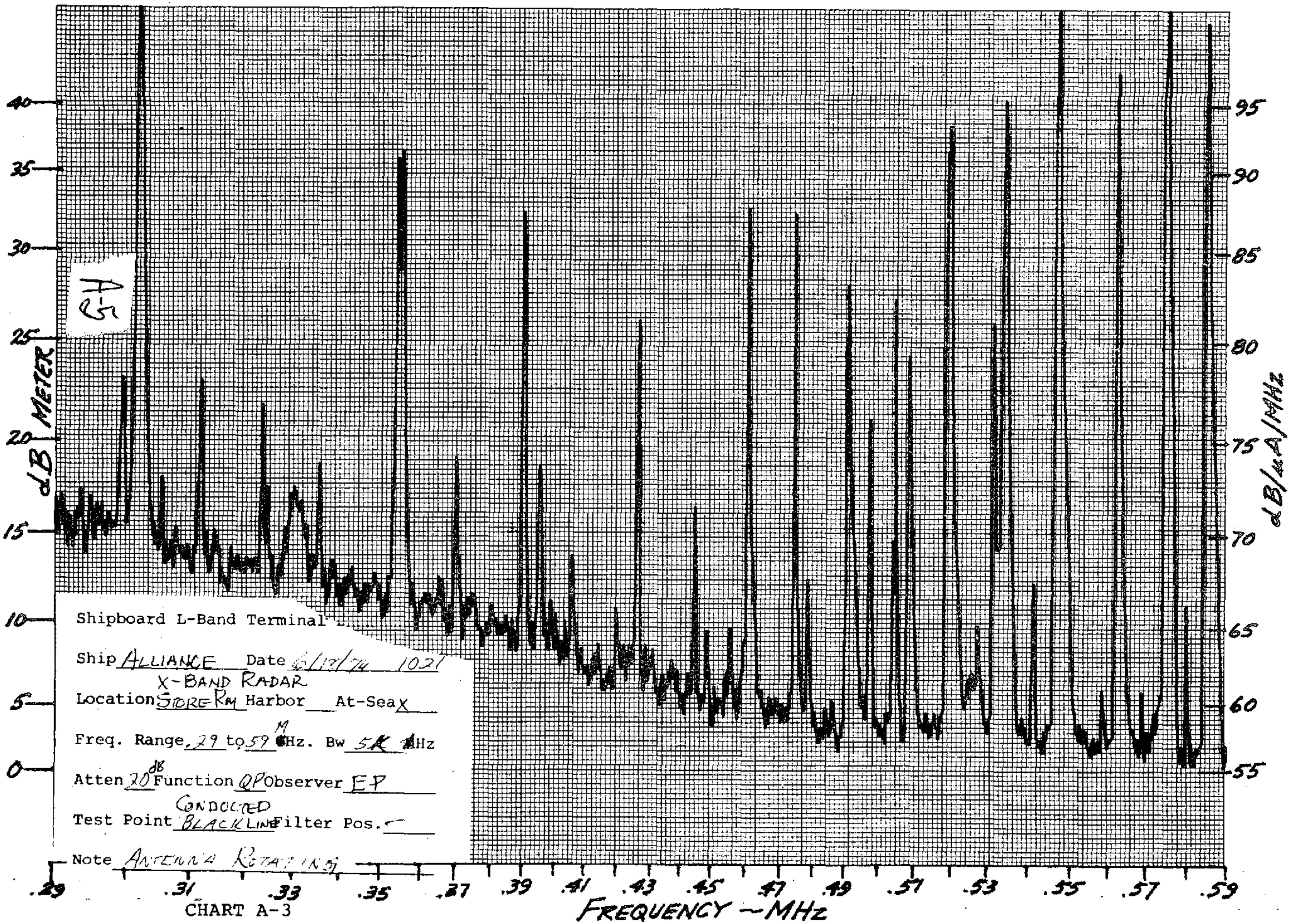

dB METER
dB/µA/MHz
40
35
30
25
20
15
10
5
0
95
90
85
80
75
70
65
60
55
A-51
Shipboard L-Band Terminal
Ship ALLIANCE Date 6/13/74 1021
X-BAND RADAR
Location STORE RM Harbor At-Sea X
Freq. Range .29 to .59 MHz. Bw 5K Hz
Atten 20 dB Function QP Observer EP
CONDUCTED
Test Point BLACK LINE Filter Pos. —
Note ANTENNA ROTATING
.29
.31
.33
.35
.37
.39
.41
.43
.45
.47
.49
.51
.53
.55
.57
.59
FREQUENCY ~ MHz

CHART A-3

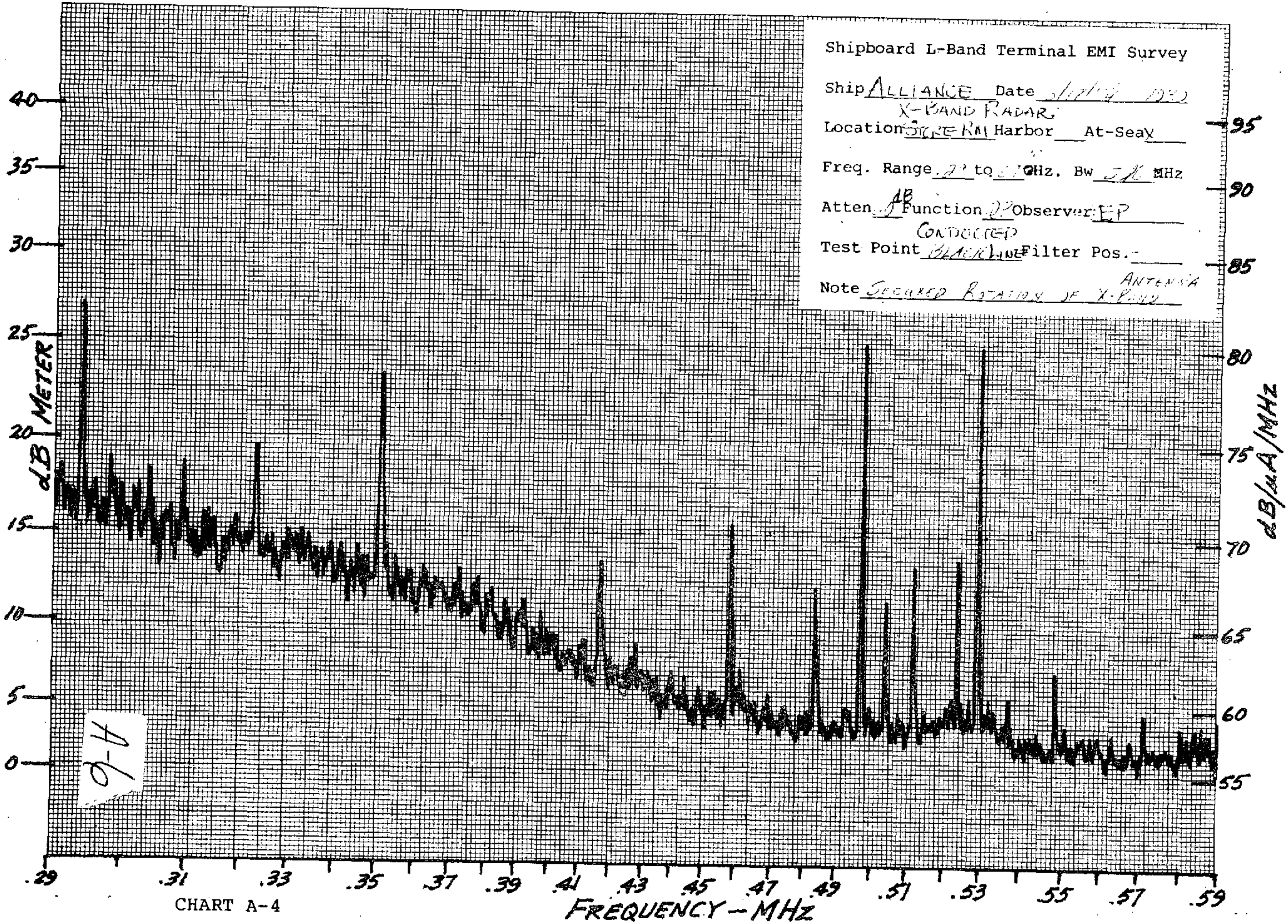

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date
X-BAND RADAR
Location Harbor At-Sea X
Freq. Range to GHz. Bw MHz
Atten dB Function Observer
CONDUCTED
Test Point Filter Pos.
Note SECURED ROTATION OF X-BAND ANTENNA
dB METER
dB/μA/MHz
FREQUENCY - MHz
.29
.31
.33
.35
.37
.39
.41
.43
.45
.47
.49
.51
.53
.55
.57
.59
40
35
30
25
20
15
10
5
0
95
90
85
80
75
70
65
60
55
9-A

CHART A-4

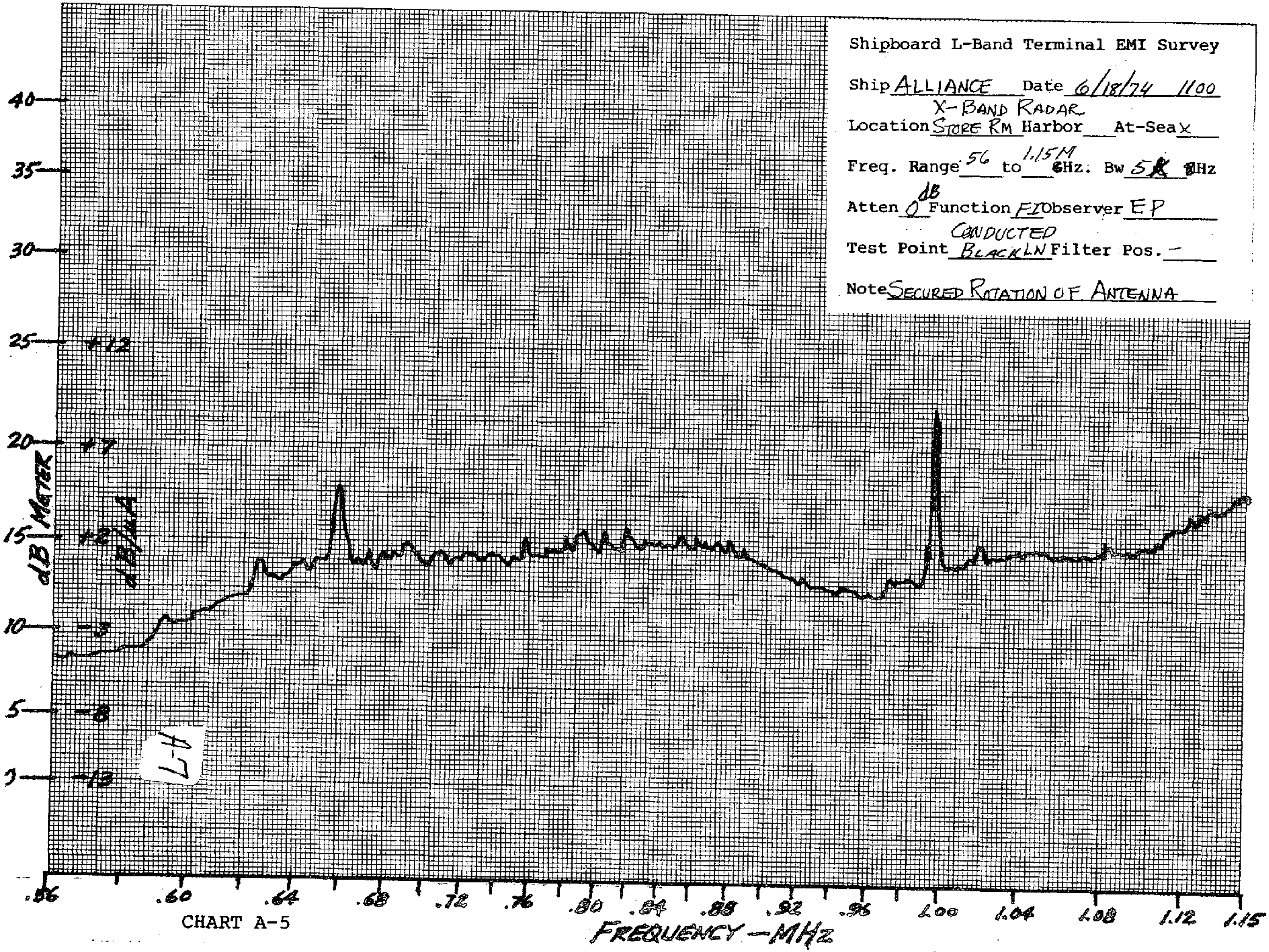

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1100
Location X-BAND RADAR STORE RM Harbor At-Sea x
Freq. Range 56 to 1.15M GHz. Bw 5K MHz
Atten 0 dB Function FI Observer EP
Test Point CONDUCTED BLACK LN Filter Pos. -
Note SECURED ROTATION OF ANTENNA
40
35
30
25 +12
20 +7
15 +2
10 -3
5 -8
0 -13
dB METER
dB/μA
LH
.56
.60
.64
.68
.72
.76
.80
.84
.88
.92
.96
1.00
1.04
1.08
1.12
1.15
FREQUENCY — MHz

CHART A-5

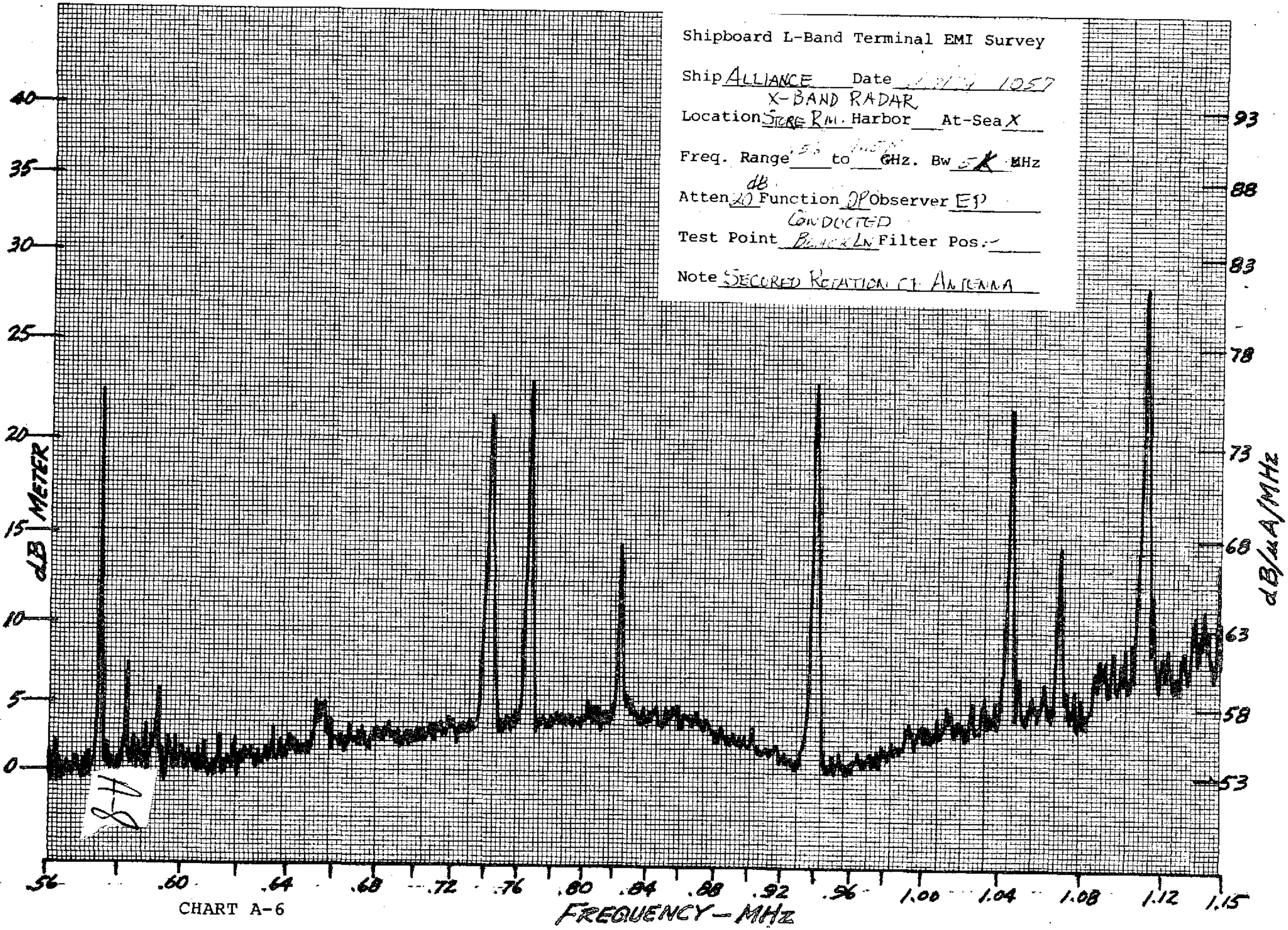

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date
X-BAND RADAR
Location STORE RM. Harbor At-Sea X
Freq. Range to GHz. Bw 5K MHz
Atten 20 dB Function PP Observer EP
CONDUCTED
Test Point Filter Pos. -
Note SECURED ROTATION OF ANTENNA
dB METER
dB/uA/MHz
40
35
30
25
20
15
10
5
0
93
88
83
78
73
68
63
58
53
.56
.60
.64
.68
.72
.76
.80
.84
.88
.92
.96
1.00
1.04
1.08
1.12
1.15
FREQUENCY — MHz
84

CHART A-6

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/18/74 1104

Location X-BAND RADAR STORE RM. Harbor ___ At-Sea X

Freq. Range 1.1 to 2.25M Hz. Bw 5K Hz

Atten 0 dB Function FI Observer EP

Test Point CONDUCTED BLACK LN Filter Pos. ___

Note SECURED ROTATION OF ANTENNA

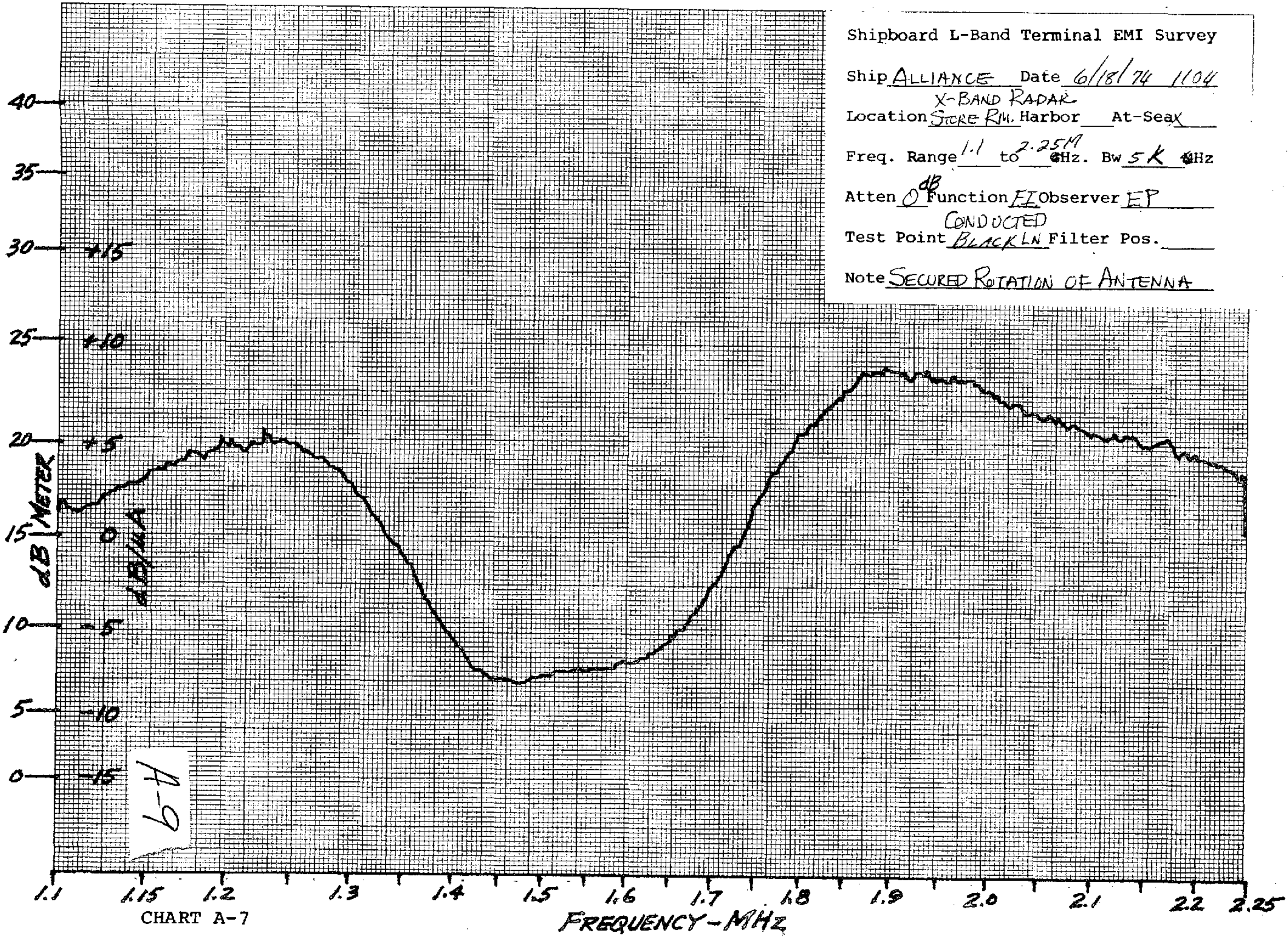


CHART A-7

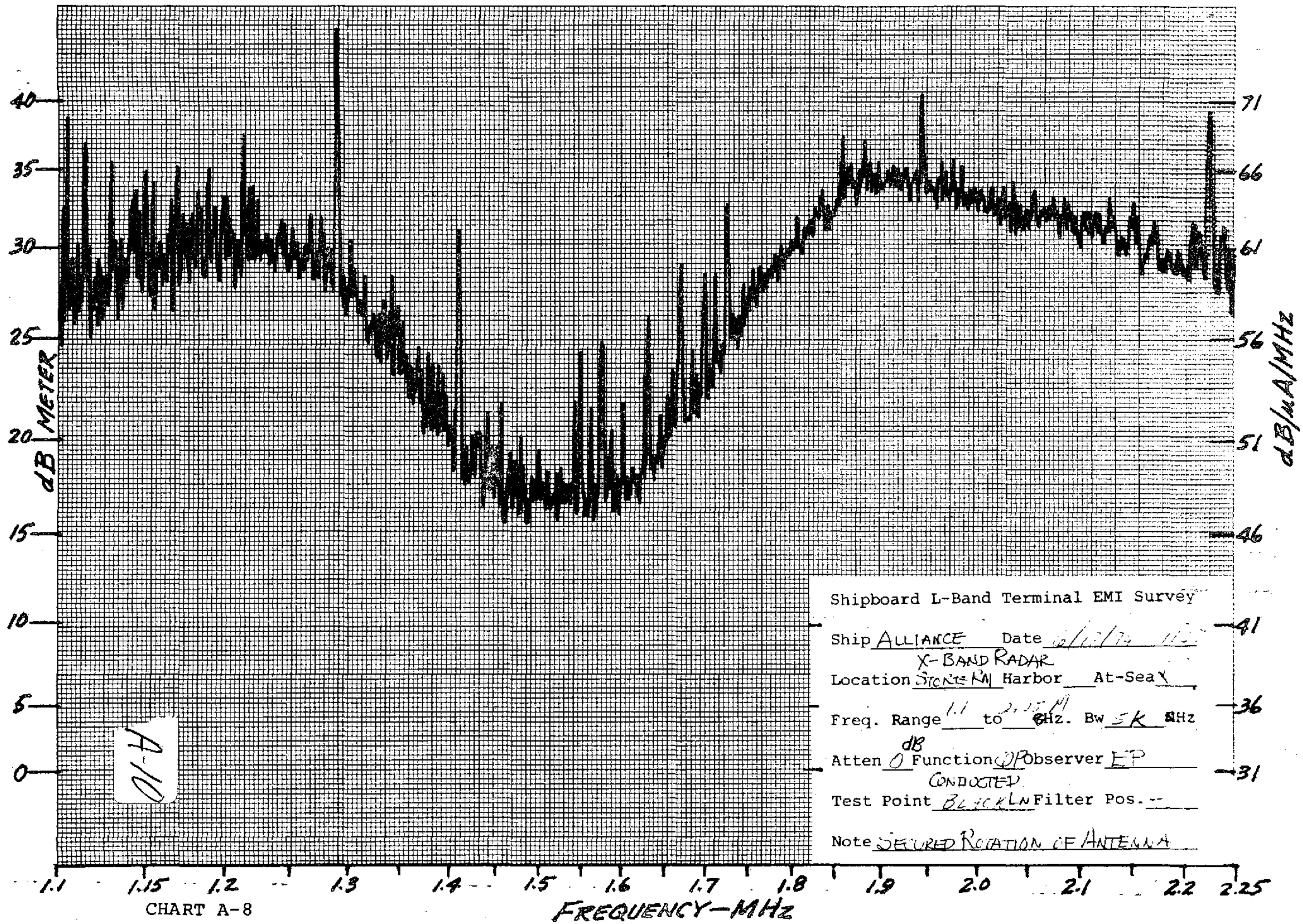
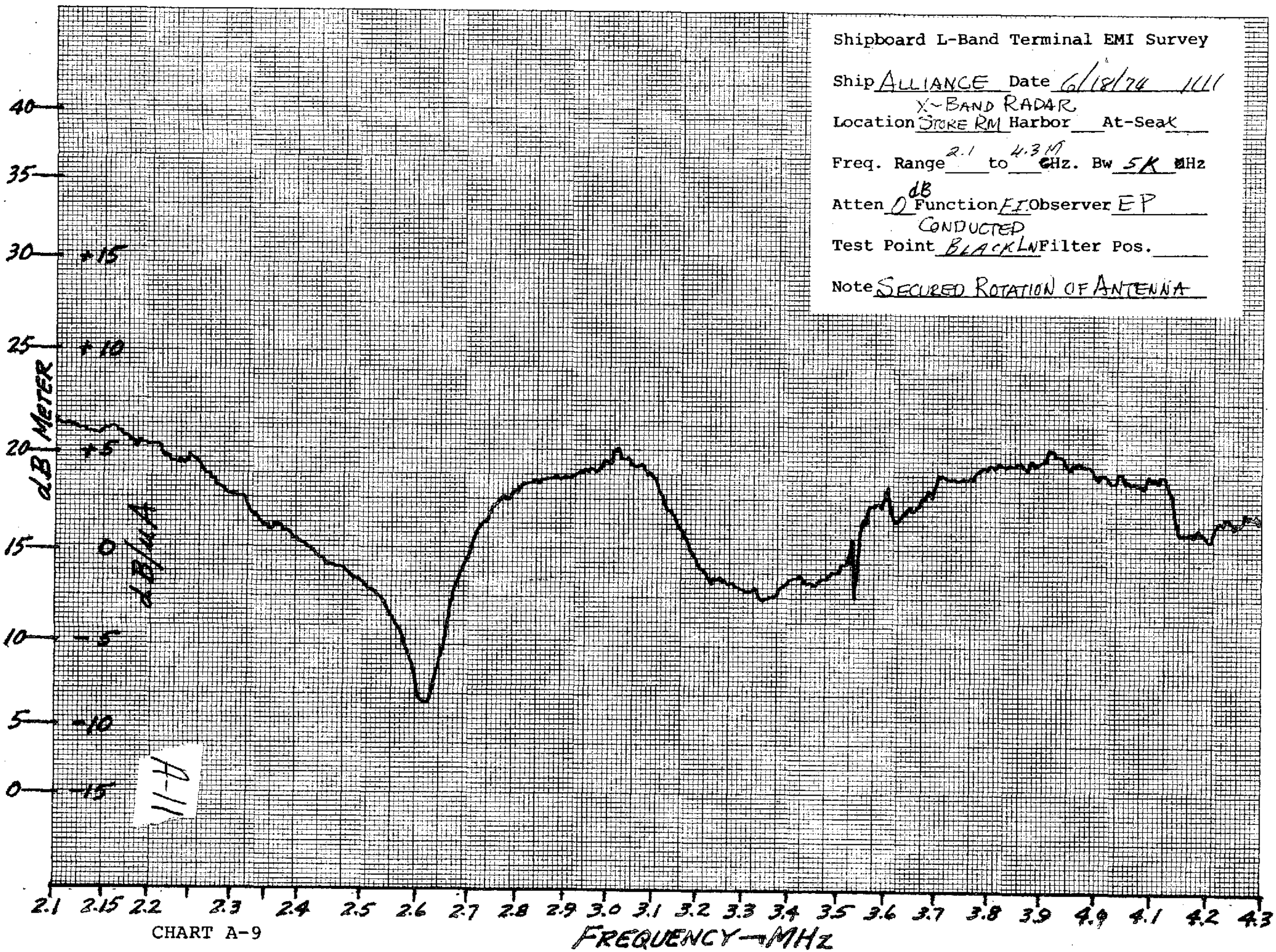
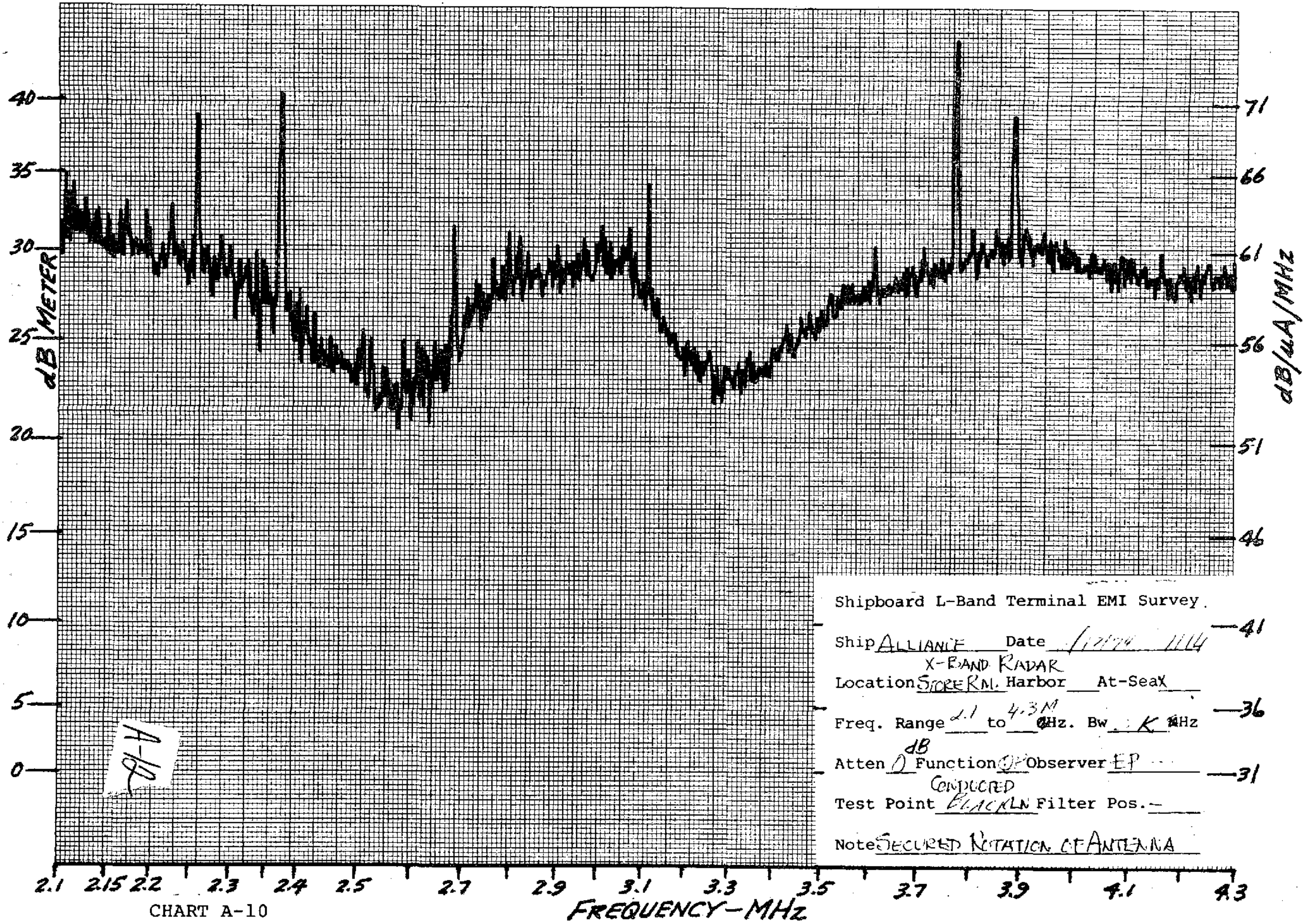

40
35
30
25
20
15
10
5
0
dB METER
71
66
61
56
51
46
41
36
31
dB/µA/MHz
1.1
1.15
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.25
FREQUENCY—MHz
A-10
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date
X-BAND RADAR
Location Harbor At-Sea X
Freq. Range 1.1 to 2.25M Hz. Bw 5K Hz
Atten 0 dB Function QP Observer EP
CONDUCTED
Test Point BLACK LN Filter Pos. --
Note SECURED ROTATION OF ANTENNA

CHART A-8



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1111
X-BAND RADAR
Location STORE RM Harbor At-Sea X
Freq. Range 2.1 to 4.3 M GHz. Bw 5K MHz
Atten 0 dB Function EI Observer EP
CONDUCTED
Test Point BLACK LN Filter Pos.
Note SECURED ROTATION OF ANTENNA
dB METER
dB/uA
40
35
30 +15
25 +10
20 +5
15 0
10 -5
5 -10
0 -15
A-11
2.1 2.15 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3
FREQUENCY → MHz

CHART A-9



Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 1/17/74 1114

X-BAND RADAR

Location STORE RM. Harbor ___ At-Sea X

Freq. Range 2.1 to 4.3M GHz. Bw 1K MHz

Atten 0 dB Function CONDUCTED Observer EP

Test Point BLACK LN Filter Pos. —

Note SECURED ROTATION OF ANTENNA

CHART A-10

KEUFFEL & ESSER CO.

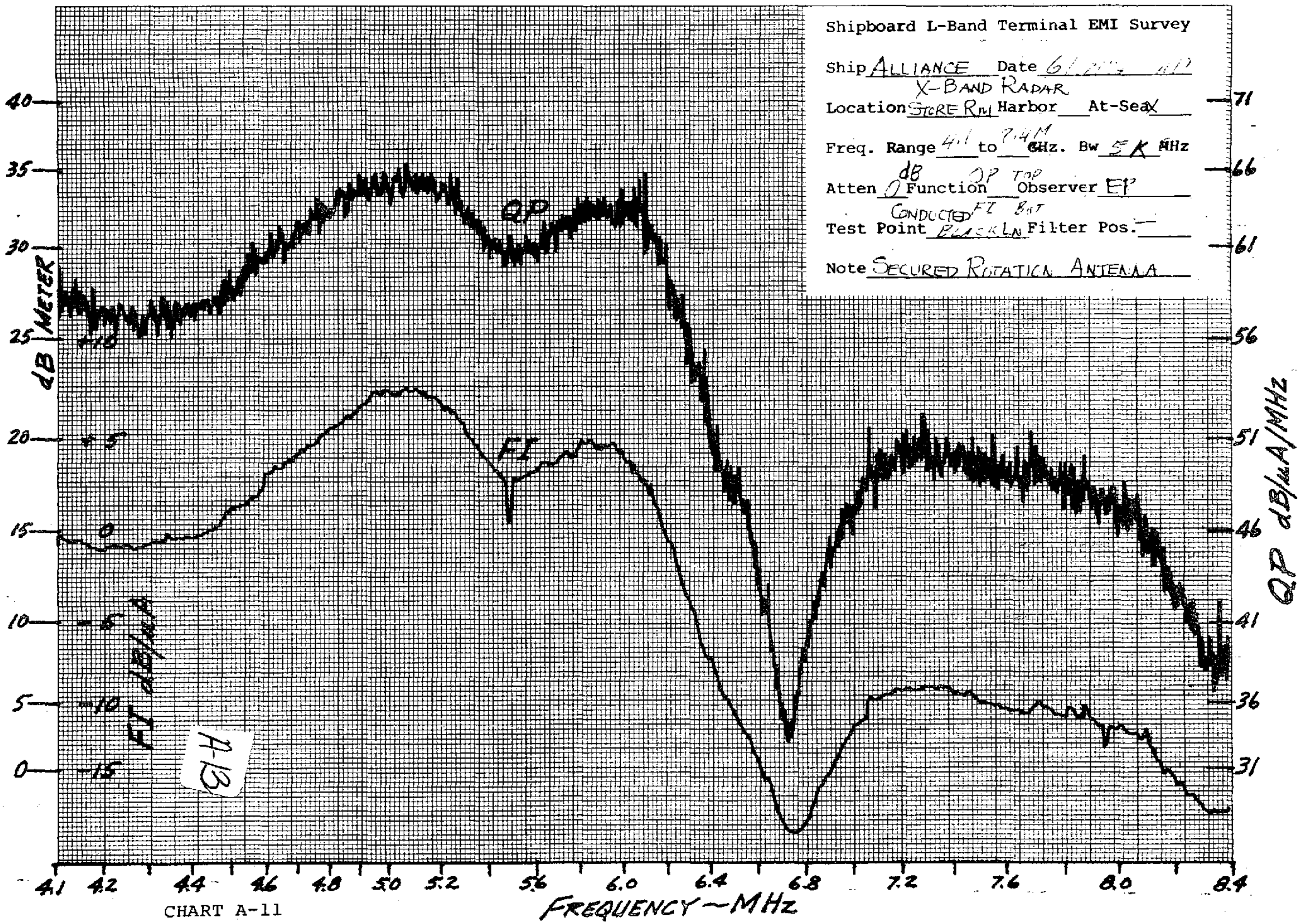
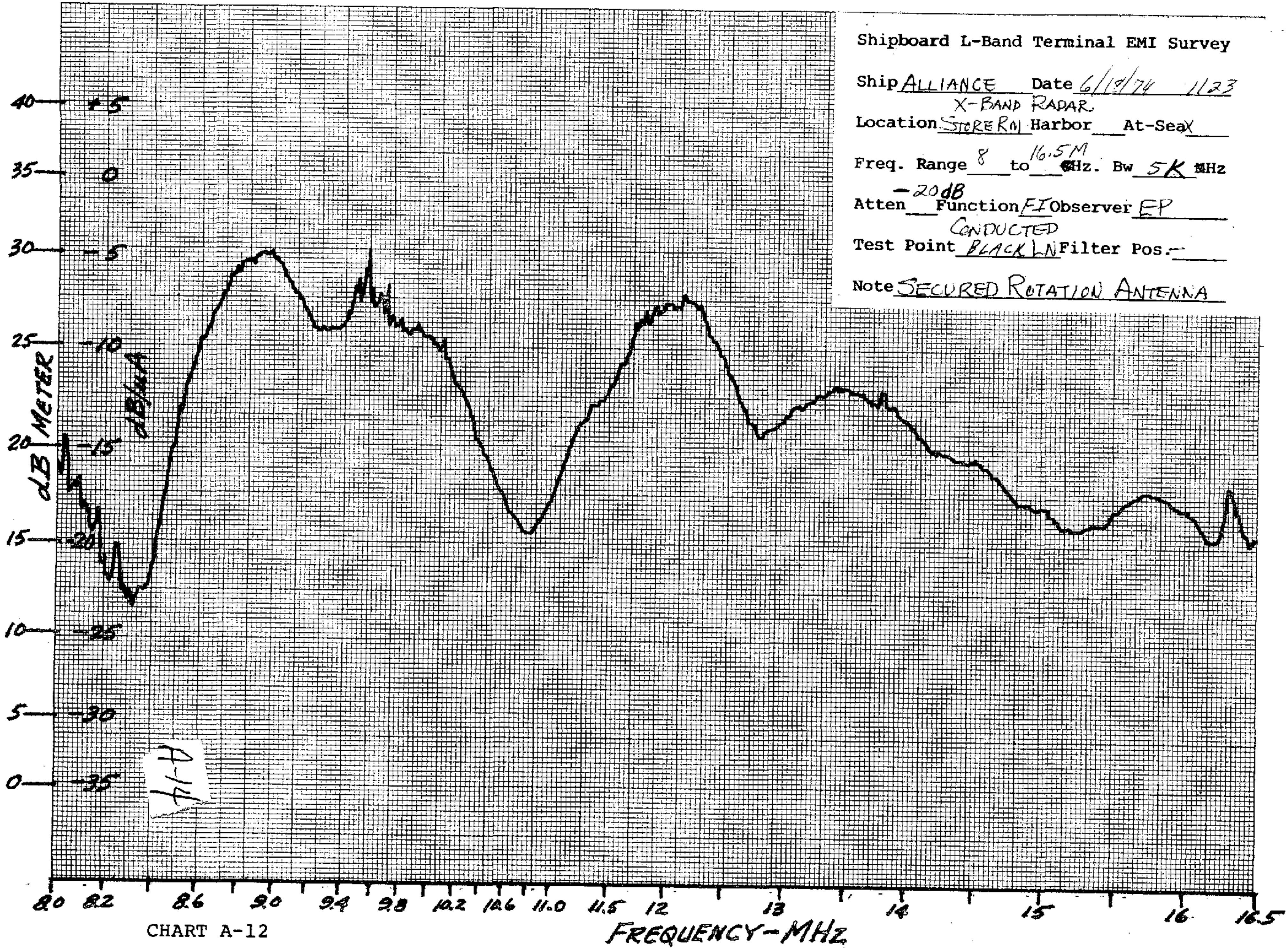


CHART A-11



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1123
X-BAND RADAR
Location STORE RM Harbor At-Sea X
Freq. Range 8 to 16.5M GHz. Bw 5K MHz
-20dB
Atten Function FI Observer EP
CONDUCTED
Test Point BLACK LN Filter Pos. -
Note SECURED ROTATION ANTENNA
dB METER
dB/uA
40 35 30 25 20 15 10 5 0
+5 0 -5 -10 -15 -20 -25 -30 -35
8.0 8.2 8.6 9.0 9.4 9.8 10.2 10.6 11.0 11.5 12 13 14 15 16 16.5
FREQUENCY-MHz

CHART A-12

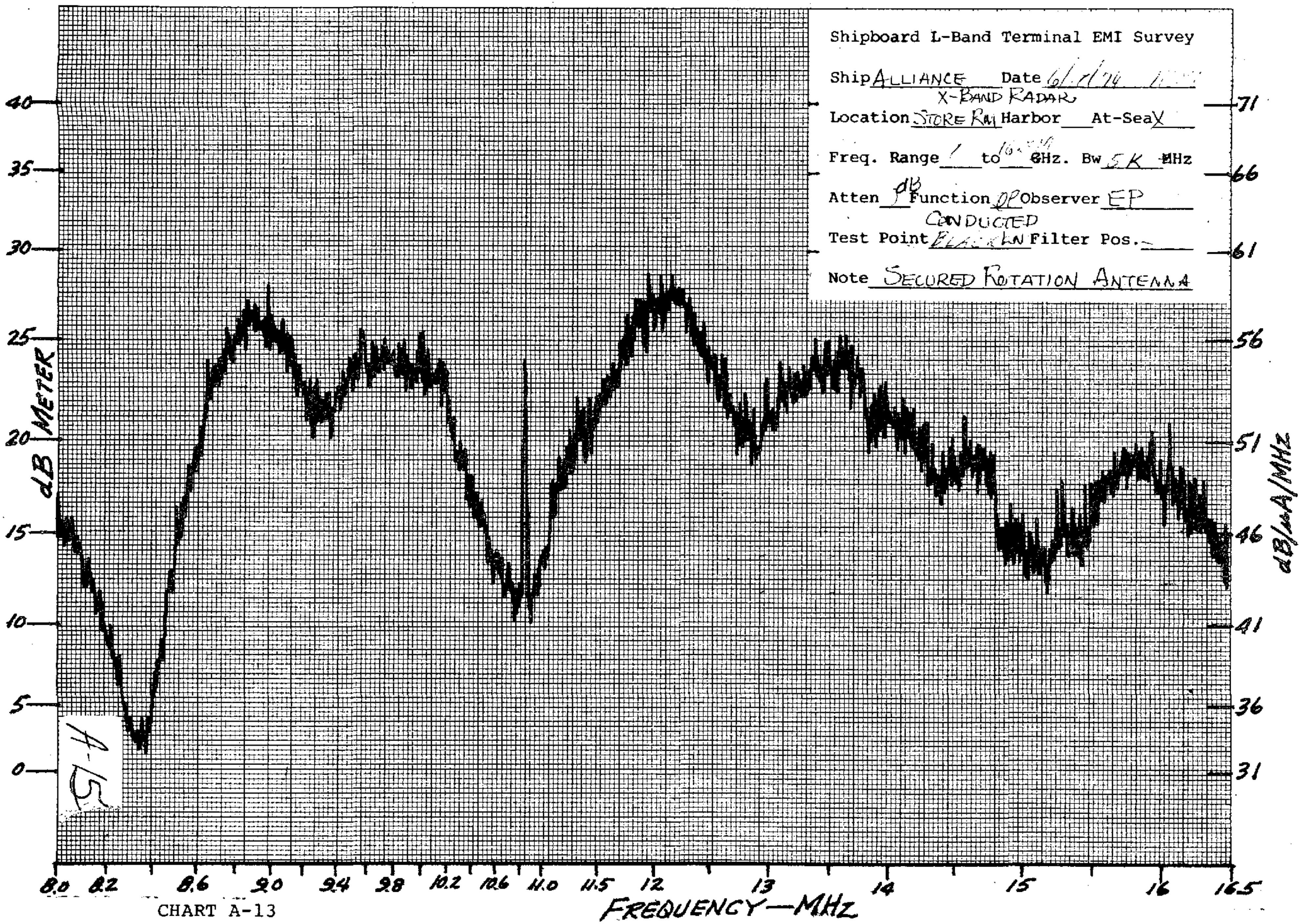
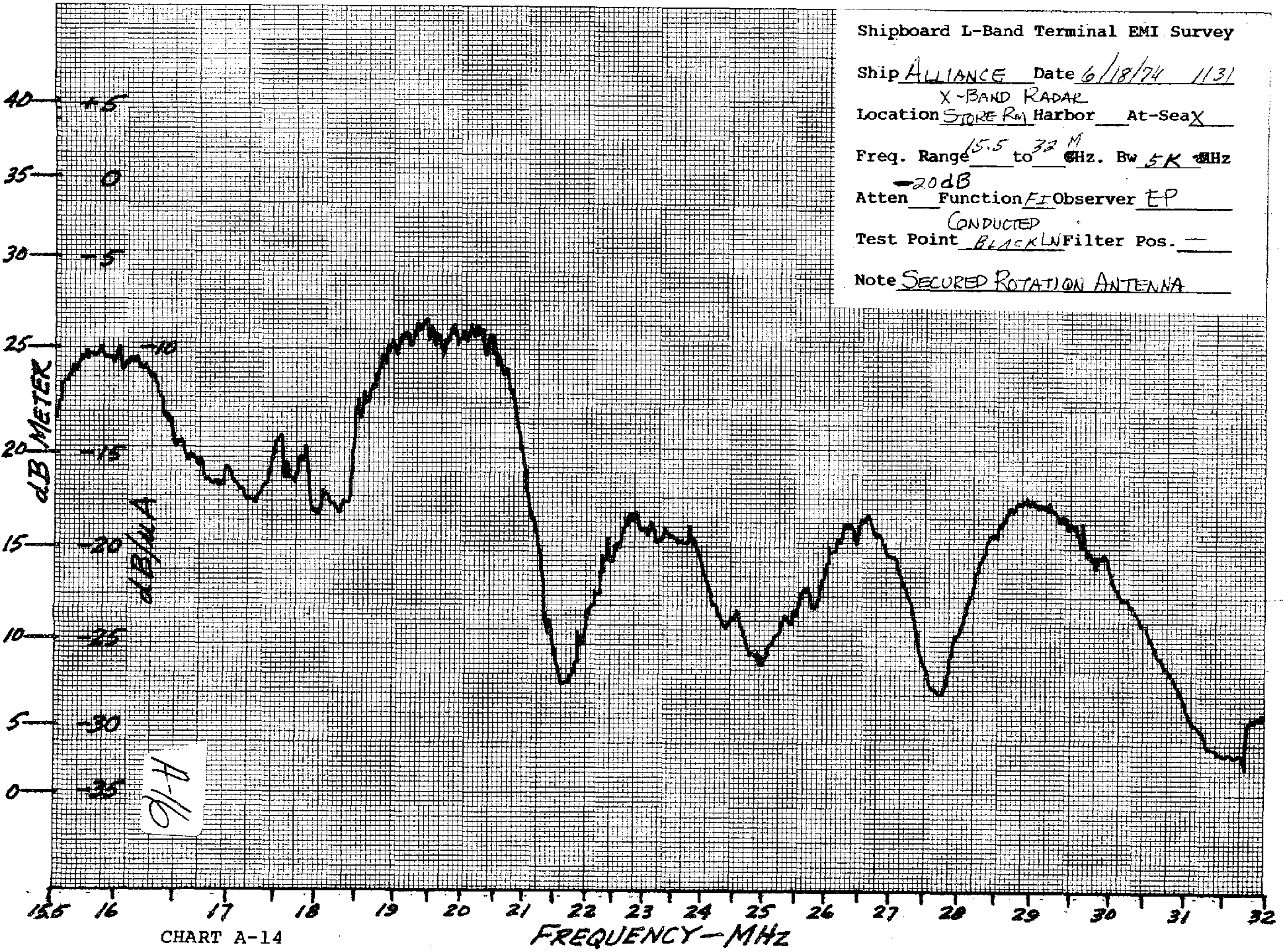

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/ /74
X-BAND RADAR
Location STORE RM Harbor At-Sea X
Freq. Range to GHz. Bw 5K MHz
Atten dB Function Observer EP
CONDUCTED
Test Point LN Filter Pos.
Note SECURED ROTATION ANTENNA
dB METER
dB/μA/MHz
40
35
30
25
20
15
10
5
0
71
66
61
56
51
46
41
36
31
8.0
8.2
8.6
9.0
9.4
9.8
10.2
10.6
11.0
11.5
12
13
14
15
16
16.5
FREQUENCY—MHz
A-15

CHART A-13



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1131
X-BAND RADAR
Location STORE RM Harbor At-Sea X
Freq. Range 15.5 to 32 MHz. Bw 5K Hz
-20dB
Atten Function FI Observer EP
CONDUCTED
Test Point BLACK LN Filter Pos. —
Note SECURED ROTATION ANTENNA
dB METER
dB/μA
40
35
30
25
20
15
10
5
0
+5
0
-5
-10
-15
-20
-25
-30
-35
15.5
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
FREQUENCY—MHz
A-16

CHART A-14

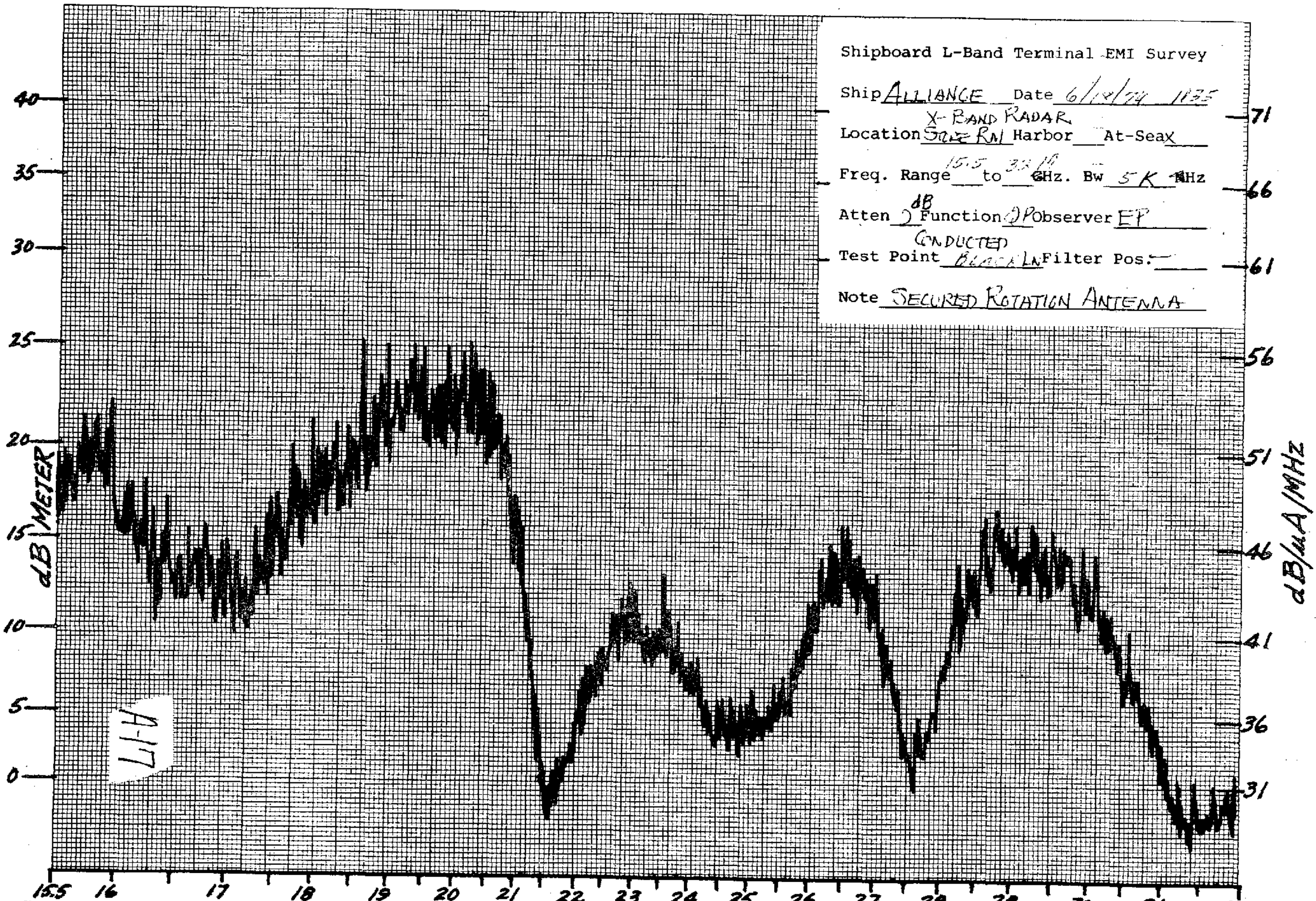

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1835
X-BAND RADAR
Location Harbor At-Sea X
Freq. Range 15.5 to 32 GHz. Bw 5K MHz
Atten dB Function Observer EP
CONDUCTED
Test Point Filter Pos.
Note SECURED ROTATION ANTENNA
dB/METER
dB/μA/MHz
LI-H
40
35
30
25
20
15
10
5
0
71
66
61
56
51
46
41
36
31
15.5
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
FREQUENCY — MHz

CHART A-15

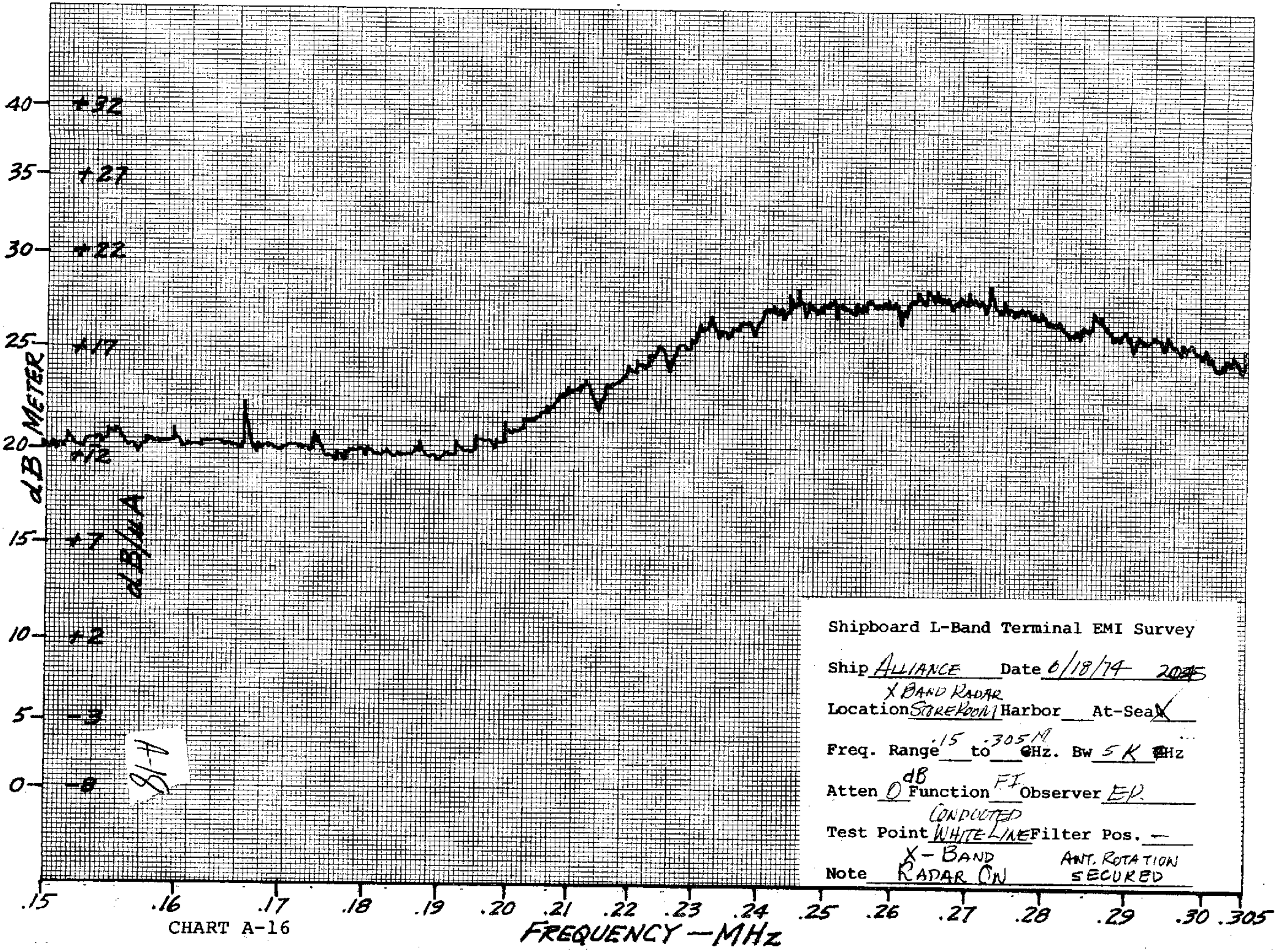

40 35 30 25 20 15 10 5 0
+32 +27 +22 +17 +12 +7 +2 -3 -8
dB METER
dB/μA
81-7
.15 .16 .17 .18 .19 .20 .21 .22 .23 .24 .25 .26 .27 .28 .29 .30 .305
FREQUENCY —MHz
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2035
Location X BAND RADAR STOREROOM Harbor __ At-Sea X
Freq. Range .15 to .305 M GHz. Bw 5 K GHz
Atten 0 dB Function FI Observer ED
Test Point CONDUCTED WHITE LINE Filter Pos. —
Note X - BAND RADAR ON ANT. ROTATION SECURED

CHART A-16

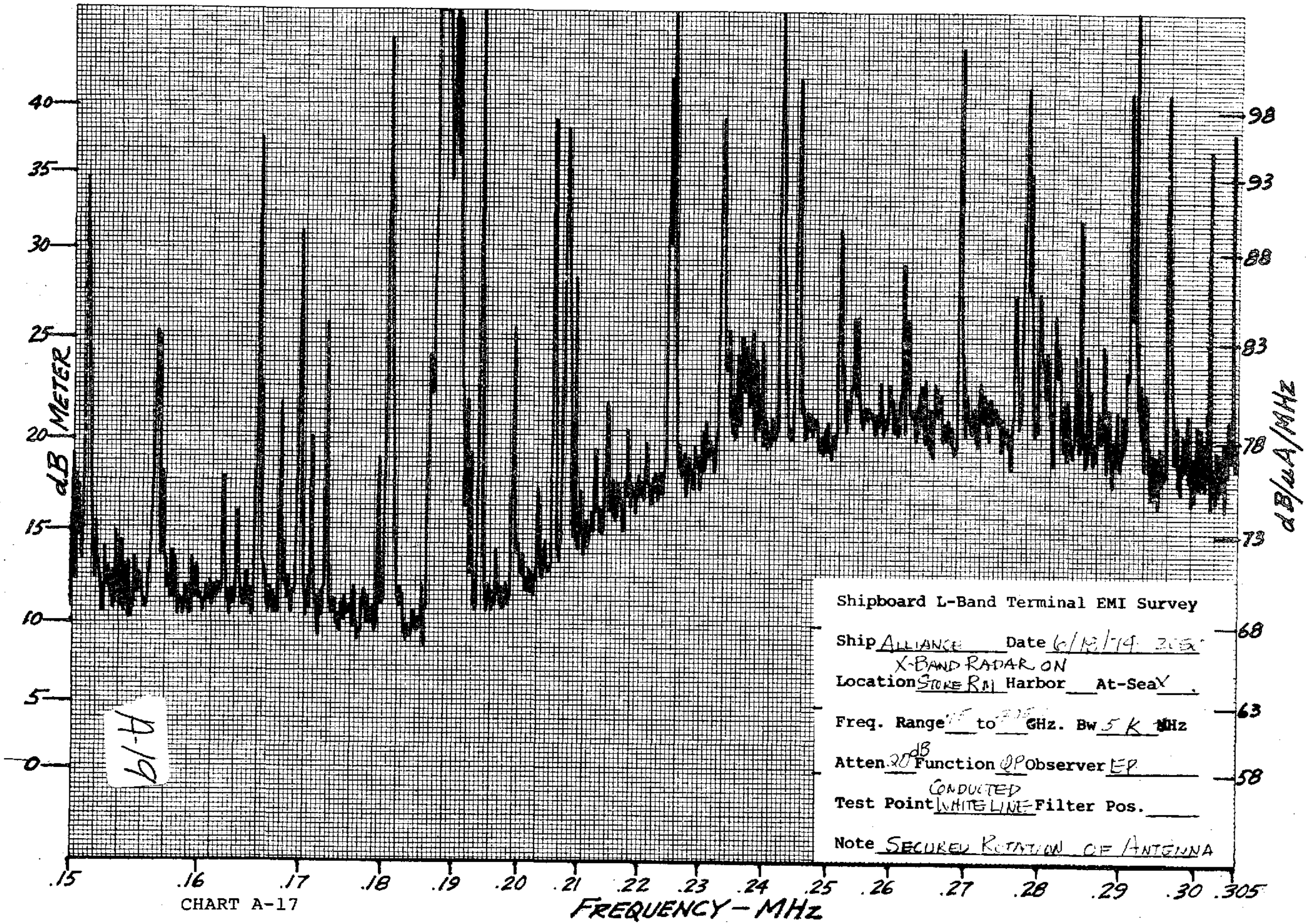

40
35
30
25
20
15
10
5
0
dB METER
98
93
88
83
78
73
68
63
58
dB/µA/MHz
.15
.16
.17
.18
.19
.20
.21
.22
.23
.24
.25
.26
.27
.28
.29
.30
.305
FREQUENCY - MHz
A-19
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/13/79 2050
X-BAND RADAR ON
Location STORE RM Harbor At-Sea X
Freq. Range .15 to .305 GHz. Bw 5 K MHz
Atten 20 dB Function QP Observer EP
CONDUCTED
Test Point WHITE LINE Filter Pos.
Note SECURED ROTATION OF ANTENNA

CHART A-17

KEUFFEL & ESSER CO.

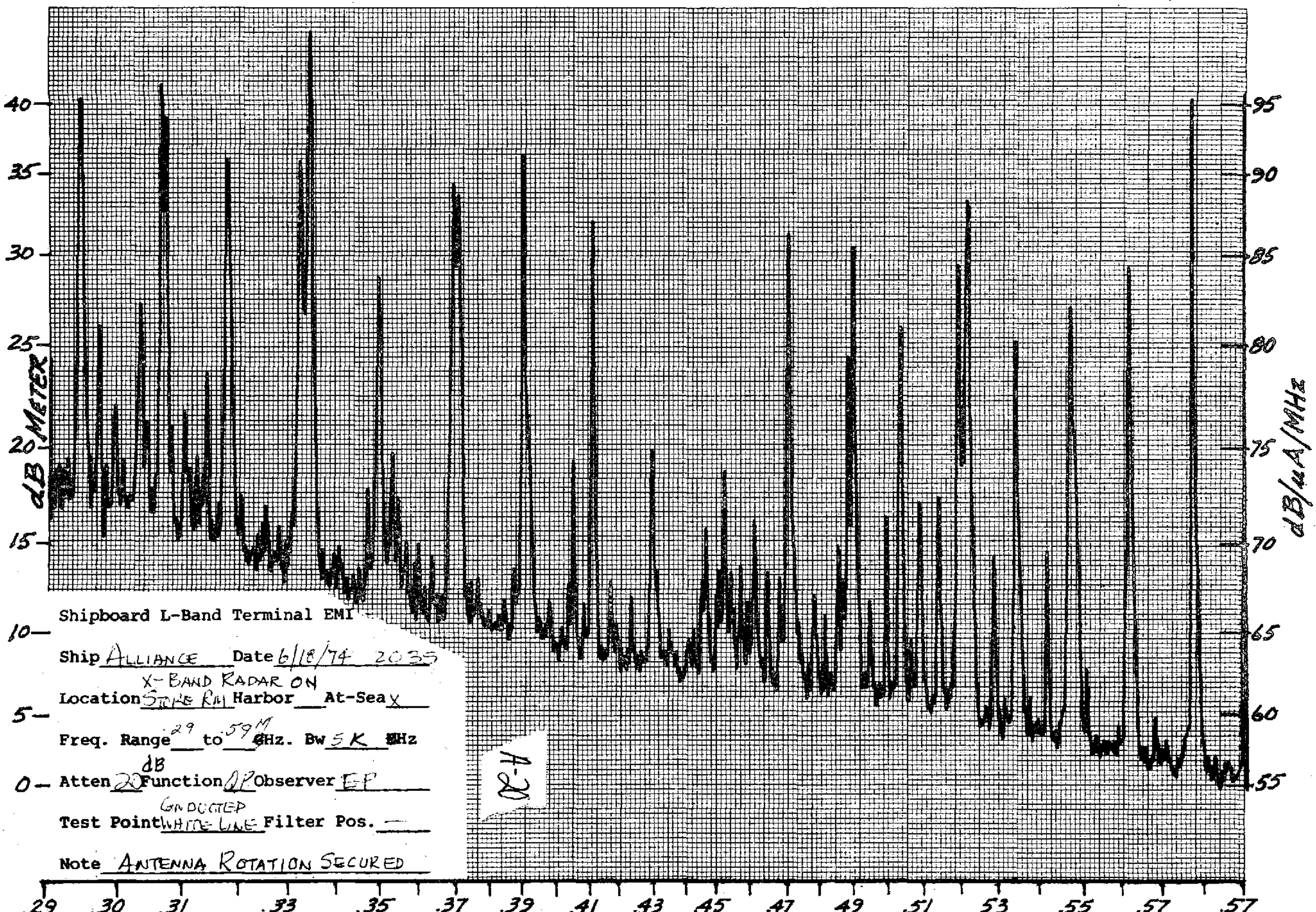
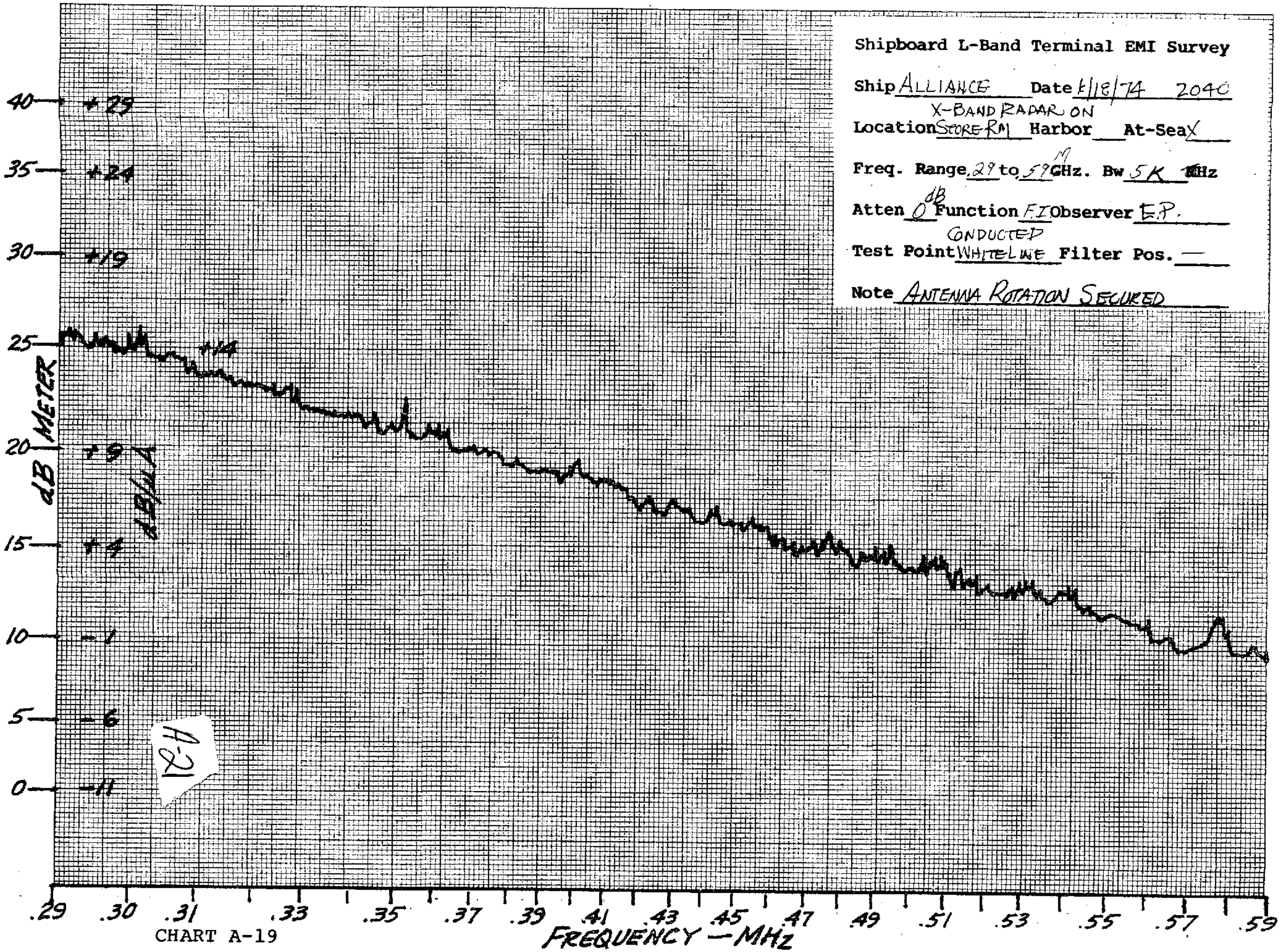


CHART A-18


Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2040
X-BAND RADAR ON
Location STORE RM Harbor At-Sea X
Freq. Range .29 to .59 MHz. Bw 5K Hz
Atten 0 dB Function F.I. Observer E.P.
CONDUCTED
Test Point WHITE LINE Filter Pos. —
Note ANTENNA ROTATION SECURED
dB METER
dB/μA
40 35 30 25 20 15 10 5 0
+29 +24 +19 +14 +9 +4 -1 -6 -11
A-21
.29 .30 .31 .33 .35 .37 .39 .41 .43 .45 .47 .49 .51 .53 .55 .57 .59
FREQUENCY — MHz
CHART A-19

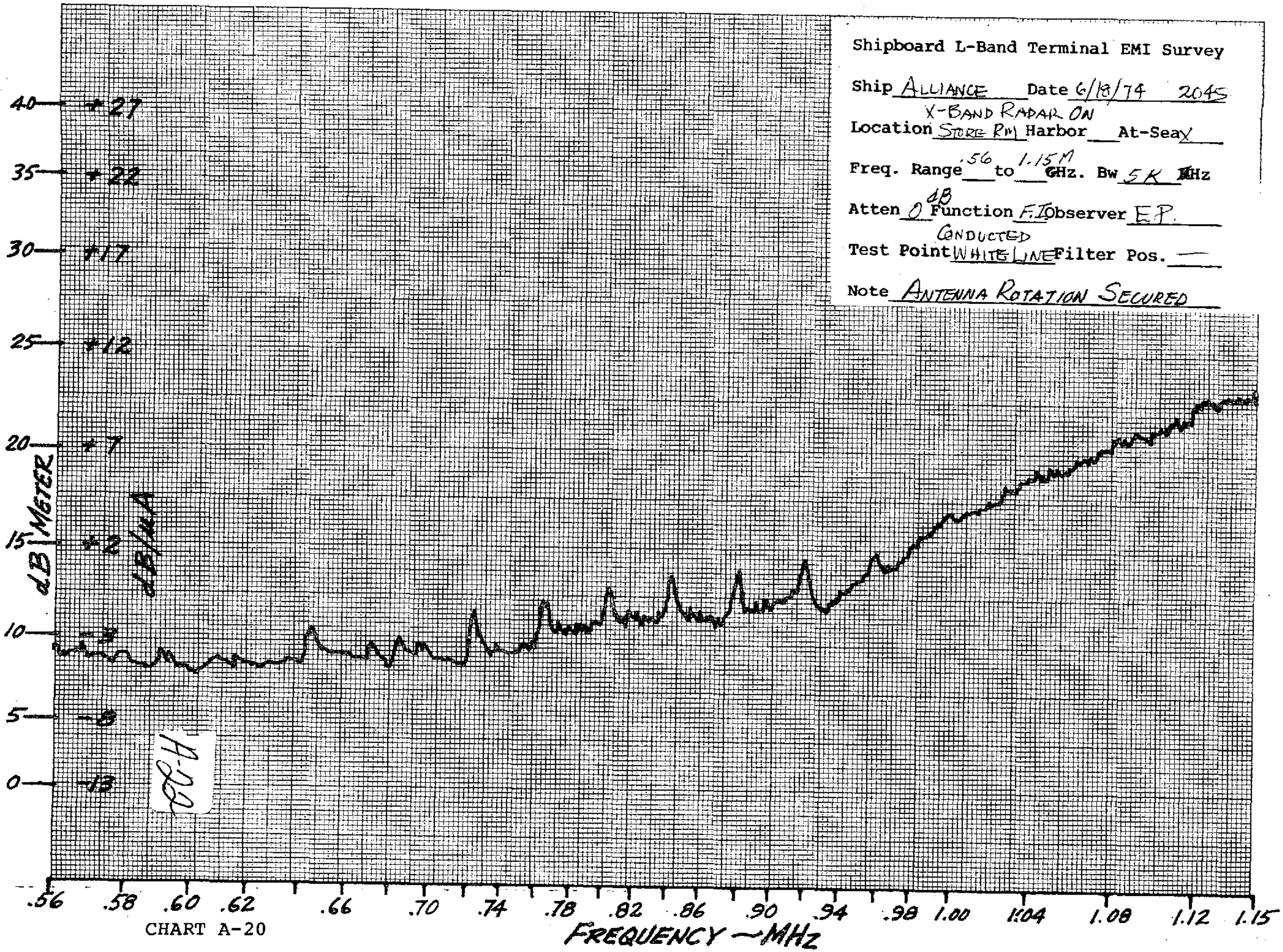
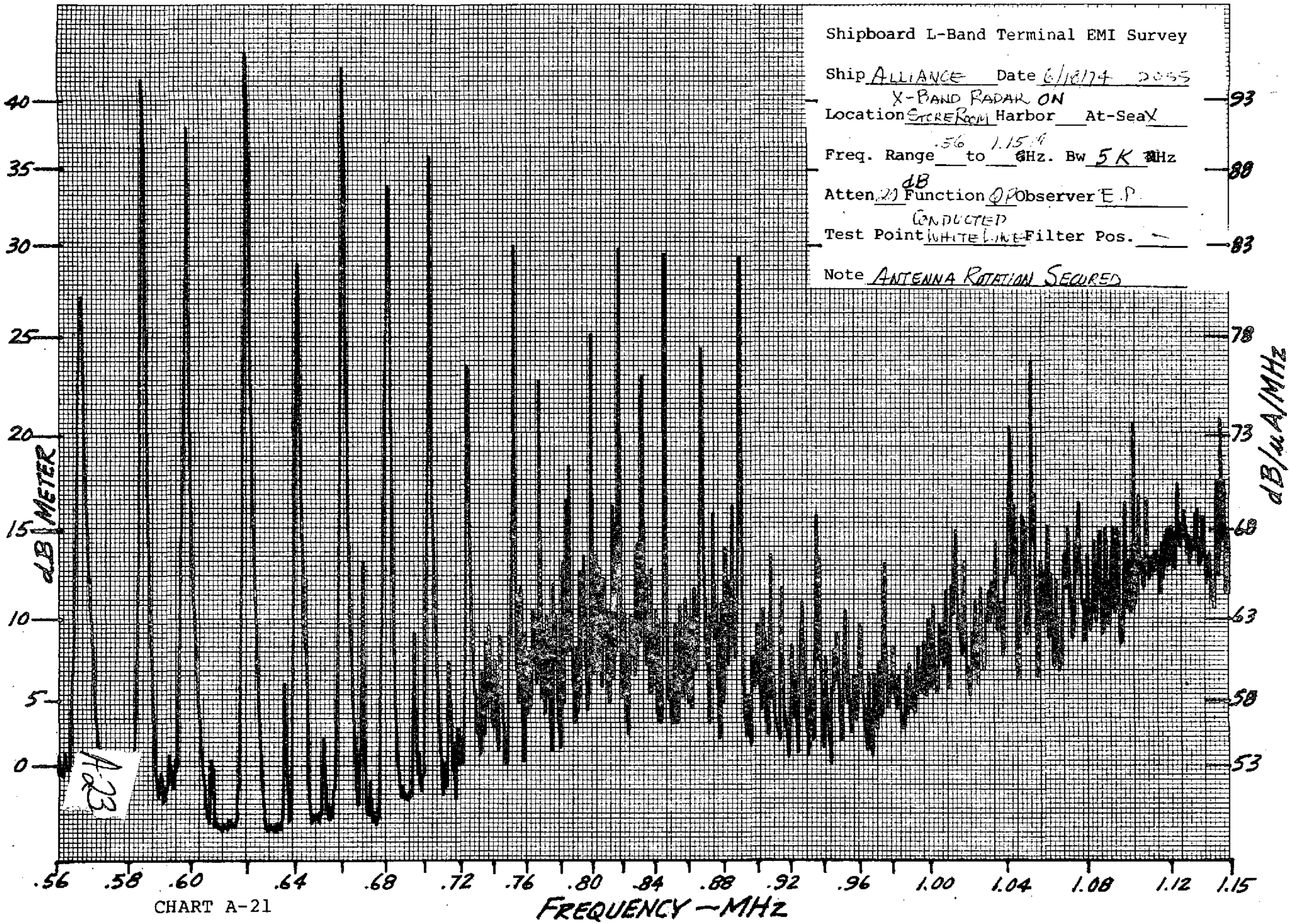
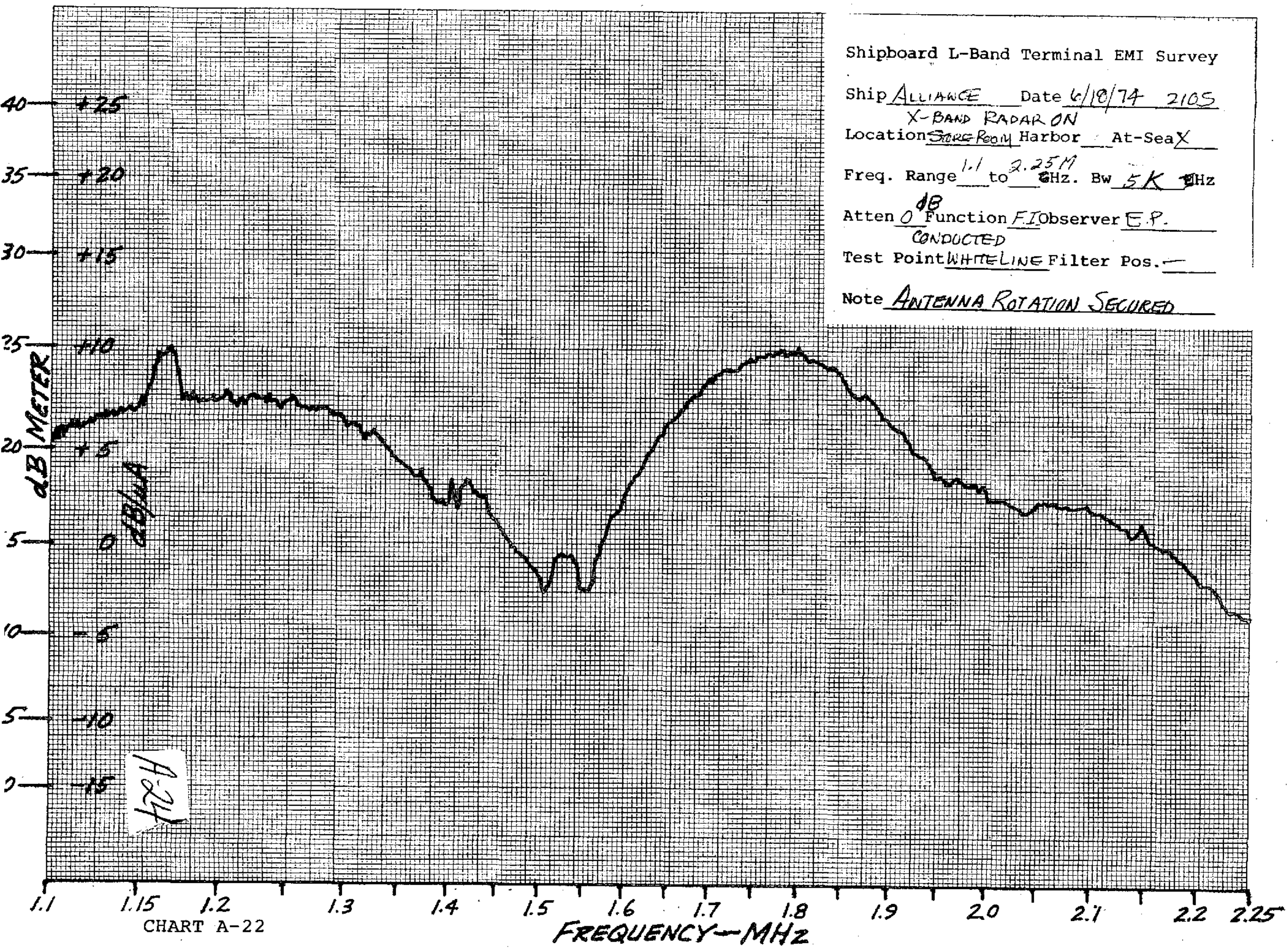

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2045
X-BAND RADAR ON
Location STORE RM Harbor At-Sea X
Freq. Range .56 to 1.15M GHz. Bw 5K MHz
Atten 0 dB Function F.I. Observer E.P.
CONDUCTED
Test Point WHITE LINE Filter Pos. —
Note ANTENNA ROTATION SECURED
dB METER
dB/μA
40 +27
35 +22
30 +17
25 +12
20 +7
15 +2
10 -3
5 -8
0 -13
.56 .58 .60 .62 .66 .70 .74 .78 .82 .86 .90 .94 .98 1.00 1.04 1.08 1.12 1.15
FREQUENCY ~ MHz

CHART A-20



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2055
X-BAND RADAR ON
Location STORE ROOM Harbor ___ At-Sea X
Freq. Range .56 to 1.154 GHz. Bw 5K MHz
Atten 20 dB Function QP Observer E.P.
CONDUCTED
Test Point WHITE LINE Filter Pos. —
Note ANTENNA ROTATION SECURED
dB METER
dB/μA/MHz
FREQUENCY — MHz
A-23

CHART A-21



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/10/74 2105
X-BAND RADAR ON
Location STORE ROOM Harbor ___ At-Sea X
Freq. Range 1.1 to 2.25M GHz. Bw 5K MHz
Atten 0 dB Function FI Observer E.P.
CONDUCTED
Test Point WHITE LINE Filter Pos. —
Note ANTENNA ROTATION SECURED
dB METER
dB/μA
40 +25
35 +20
30 +15
25 +10
20 +5
15 0
10 -5
5 -10
0 -15
1.1 1.15 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.25
FREQUENCY—MHz
A-24

CHART A-22

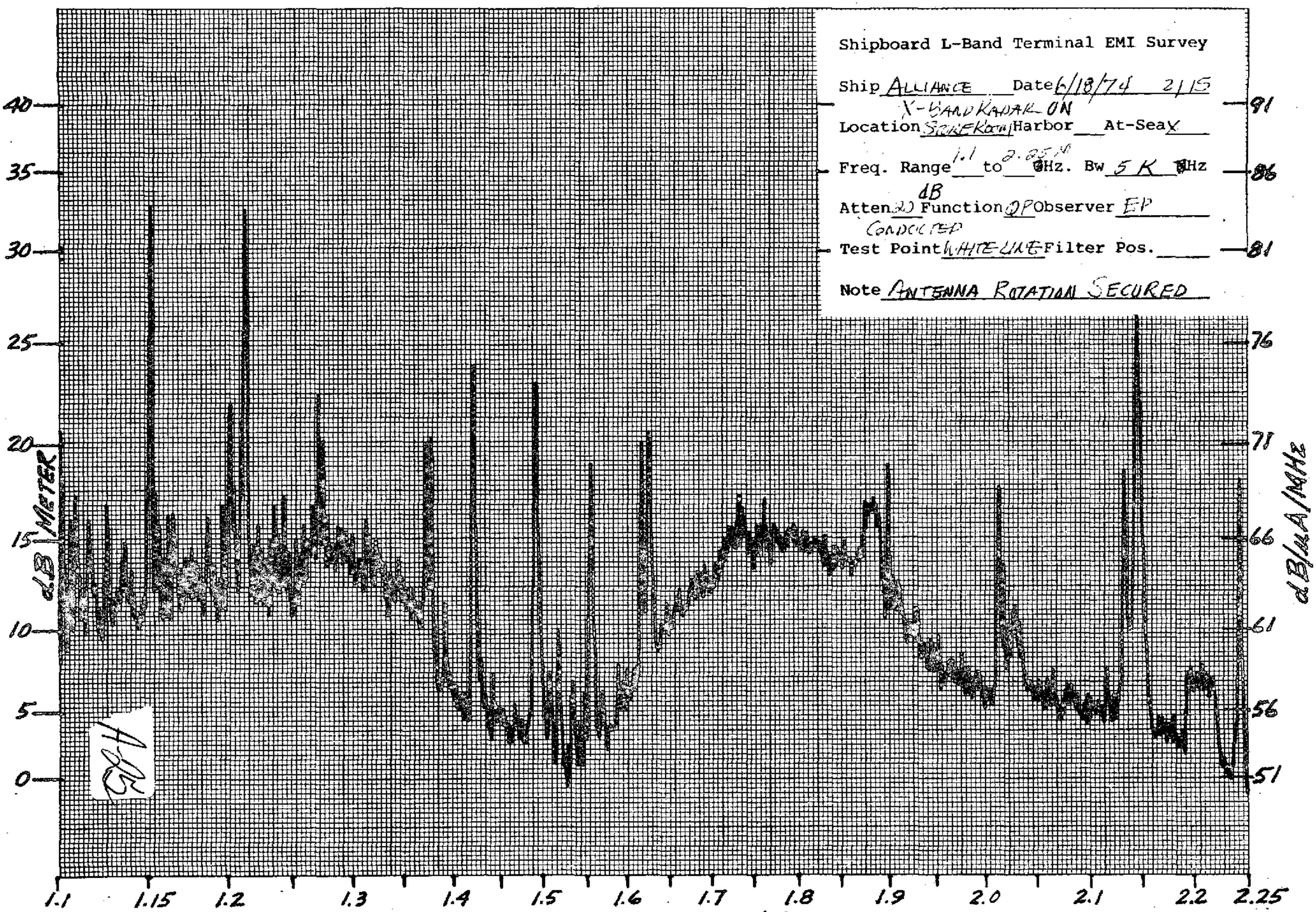

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2/15
X-BAND RADAR ON
Location SEREKOMI Harbor At-Sea X
Freq. Range 1.1 to 2.25 M GHz. Bw 5 K MHz
Atten 20 dB Function QP Observer EP
CONDUCTED
Test Point WHITE LINE Filter Pos.
Note ANTENNA ROTATION SECURED
dB/METER
dB/μA/MHz
40
35
30
25
20
15
10
5
0
91
86
81
76
71
66
61
56
51
1.1
1.15
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.25
FREQUENCY—MHz
A-84

CHART A-23

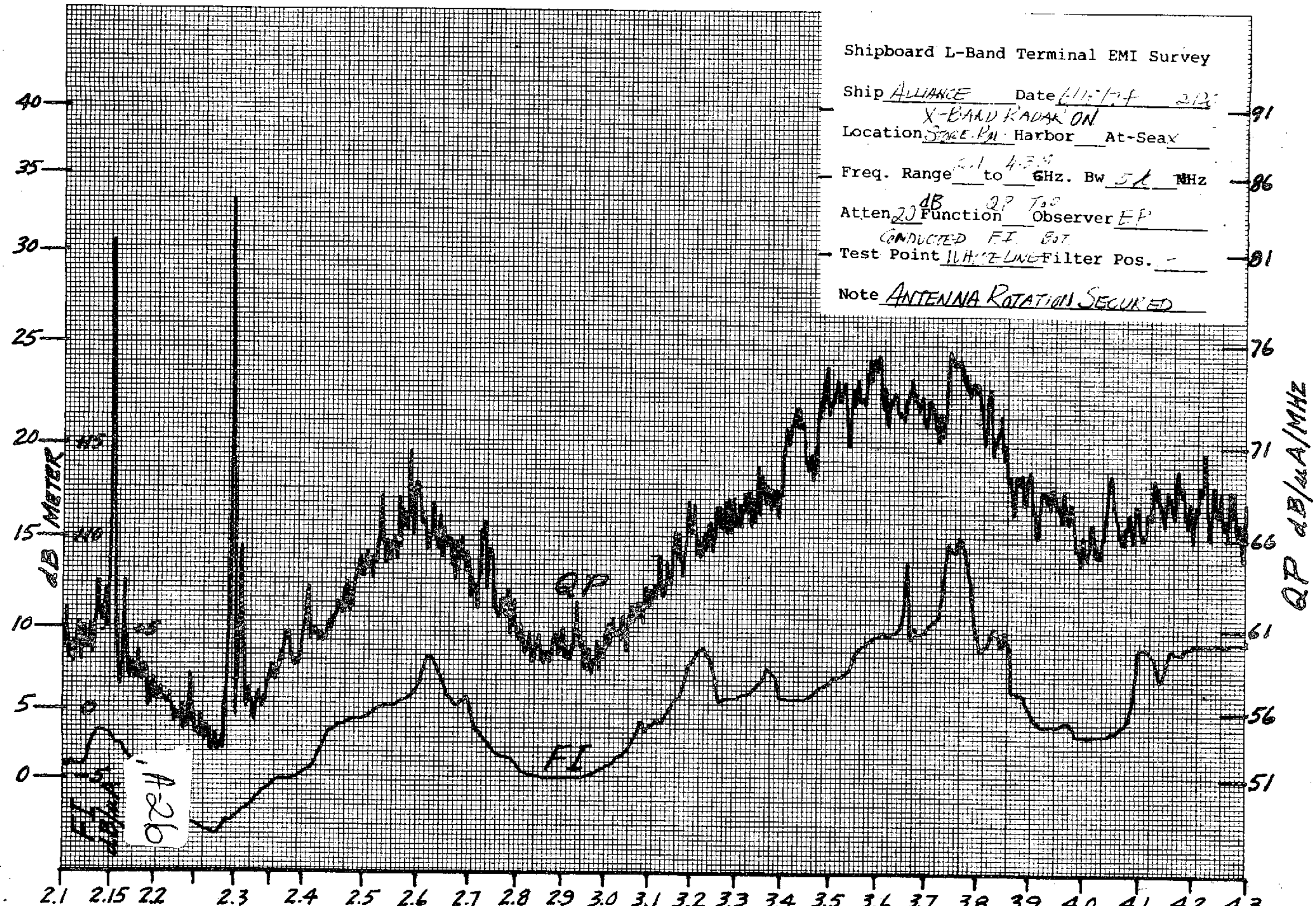


CHART A-24

FREQUENCY — MHz

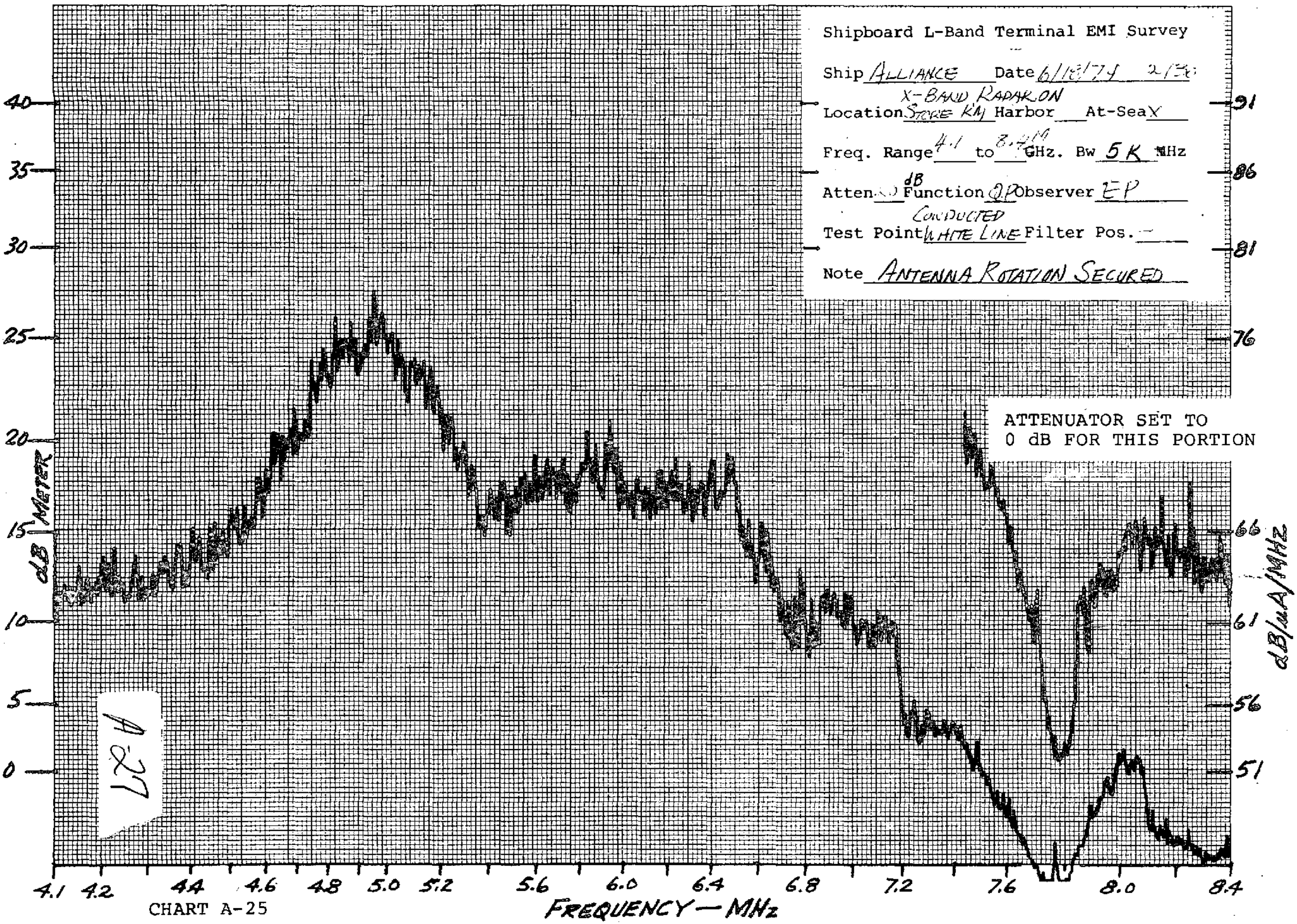
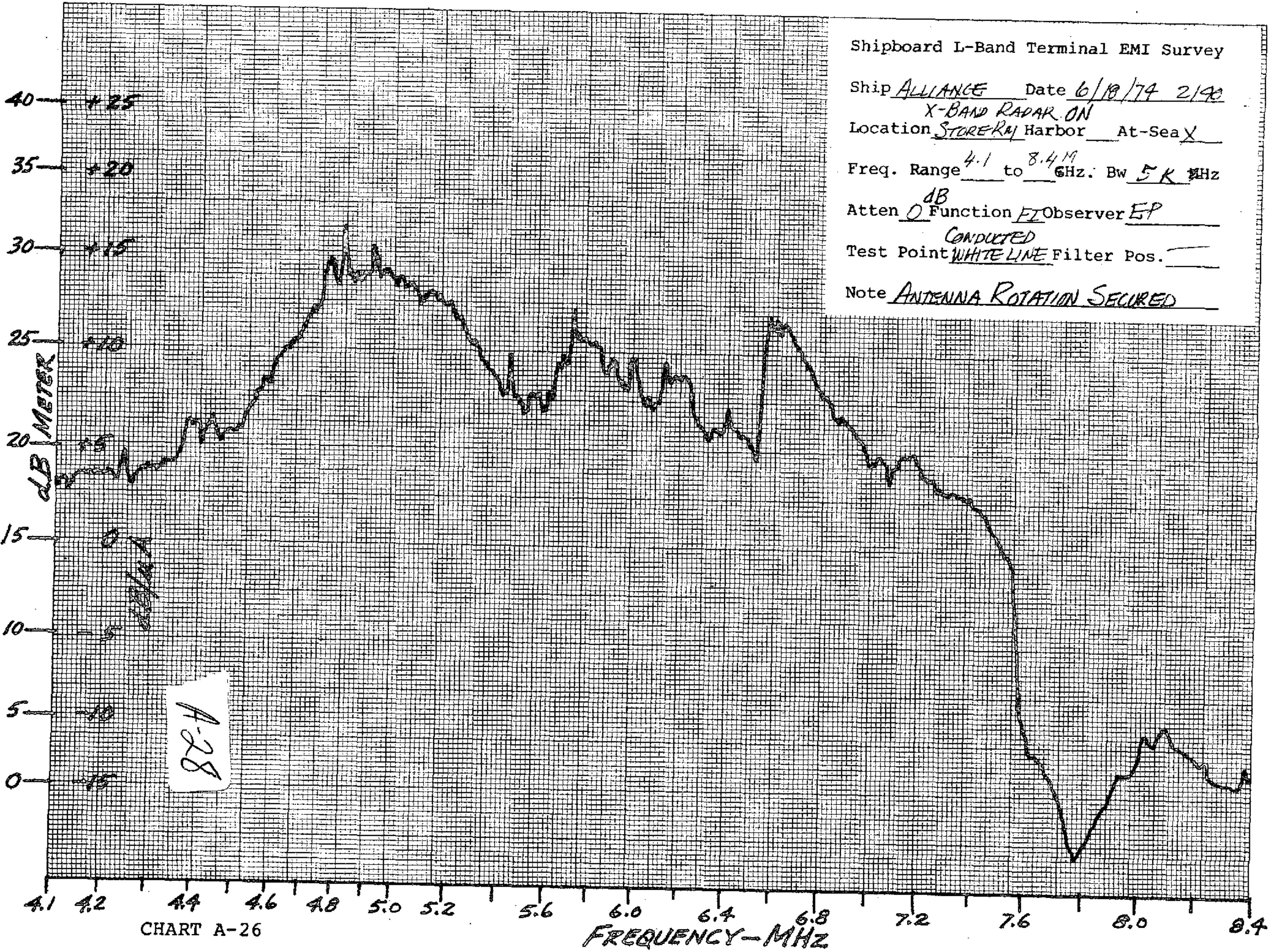
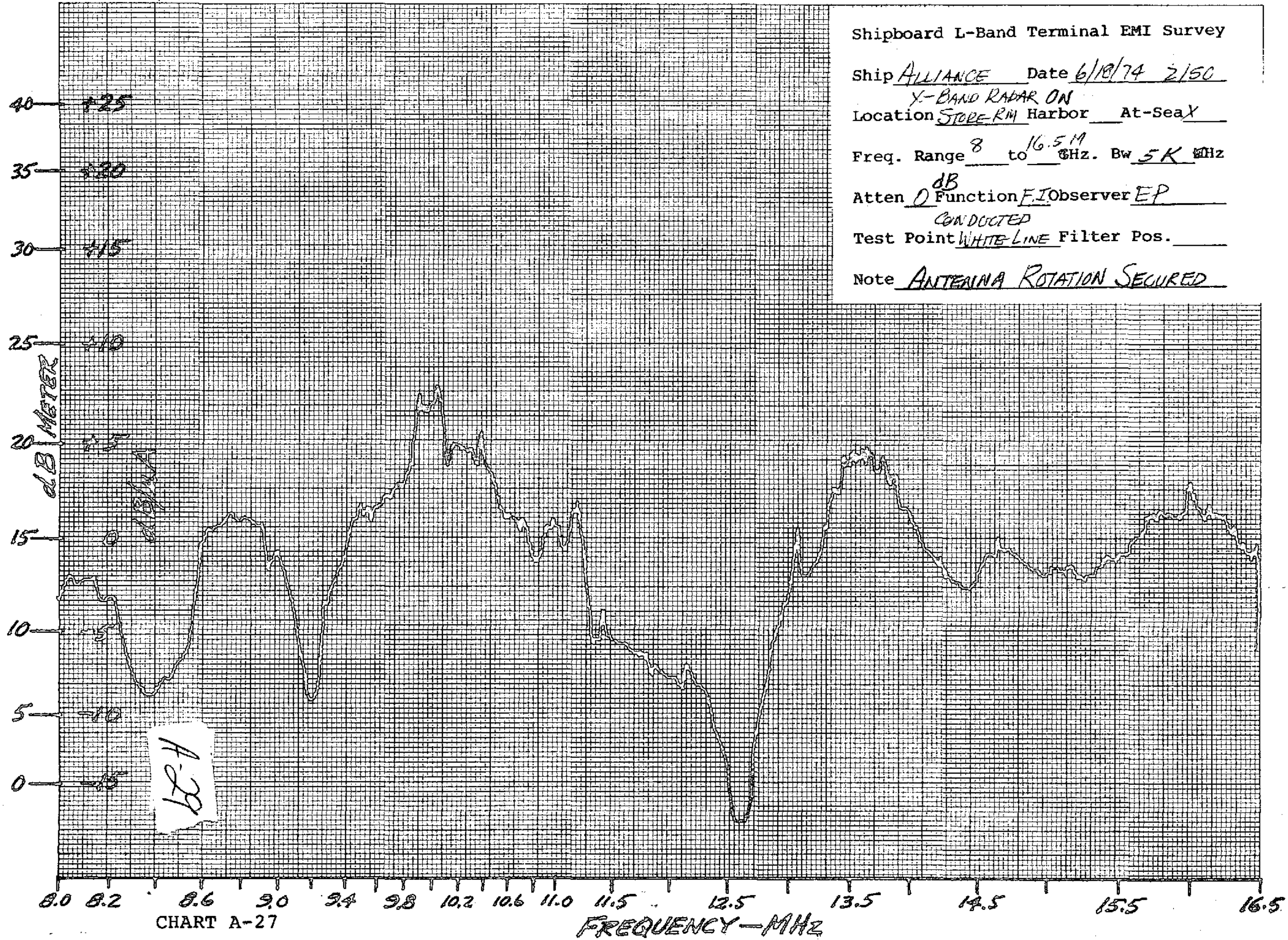

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2/30
X-BAND RADAR ON
Location STORE KM Harbor ___ At-Sea X
Freq. Range 4.1 to 8.4M GHz. Bw 5K MHz
Atten dB Function QP Observer EP
CONDUCTED
Test Point WHITE LINE Filter Pos. –
Note ANTENNA ROTATION SECURED
ATTENUATOR SET TO
0 dB FOR THIS PORTION
dB METER
dB/uA/MHz
40
35
30
25
20
15
10
5
0
91
86
81
76
66
61
56
51
4.1
4.2
4.4
4.6
4.8
5.0
5.2
5.6
6.0
6.4
6.8
7.2
7.6
8.0
8.4
FREQUENCY — MHz
A-27

CHART A-25



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2140
X-BAND RADAR ON
Location STORE-RM Harbor At-Sea X
Freq. Range 4.1 to 8.4 MHz. Bw 5 K Hz
Atten 0 dB Function FI Observer EP
Test Point CONDUCTED WHITE LINE Filter Pos.
Note ANTENNA ROTATION SECURED
dB METER
dB/μA
40
35
30
25
20
15
10
5
0
+25
+20
+15
+10
+5
0
-5
-10
-15
A-28
4.1
4.2
4.4
4.6
4.8
5.0
5.2
5.6
6.0
6.4
6.8
7.2
7.6
8.0
8.4
FREQUENCY—MHz

CHART A-26



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2150
X-BAND RADAR ON
Location STORE RM Harbor ___ At-Sea X
Freq. Range 8 to 16.5 M GHz. Bw 5K MHz
Atten 0 dB Function F.I. Observer EP
CONDUCTED
Test Point WHITE LINE Filter Pos. ___
Note ANTENNA ROTATION SECURED
40
35
30
25
20
15
10
5
0
+25
+20
+15
+10
+5
0
-5
-10
-15
dB METER
dB/μA
A-27
8.0
8.2
8.6
9.0
9.4
9.8
10.2
10.6
11.0
11.5
12.5
13.5
14.5
15.5
16.5
FREQUENCY—MHz

CHART A-27

KEUFFEL & ESSER CO.

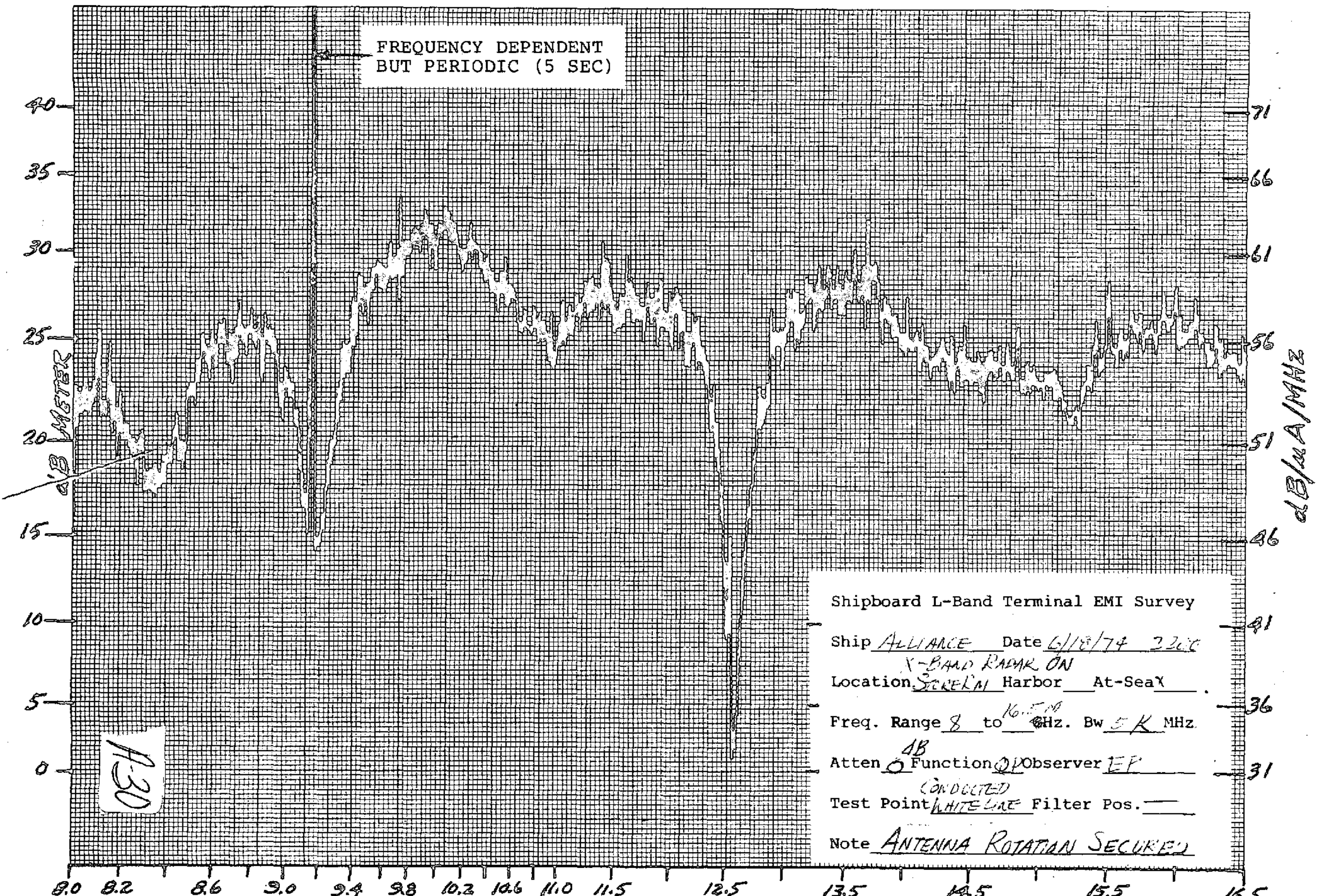


CHART A-28

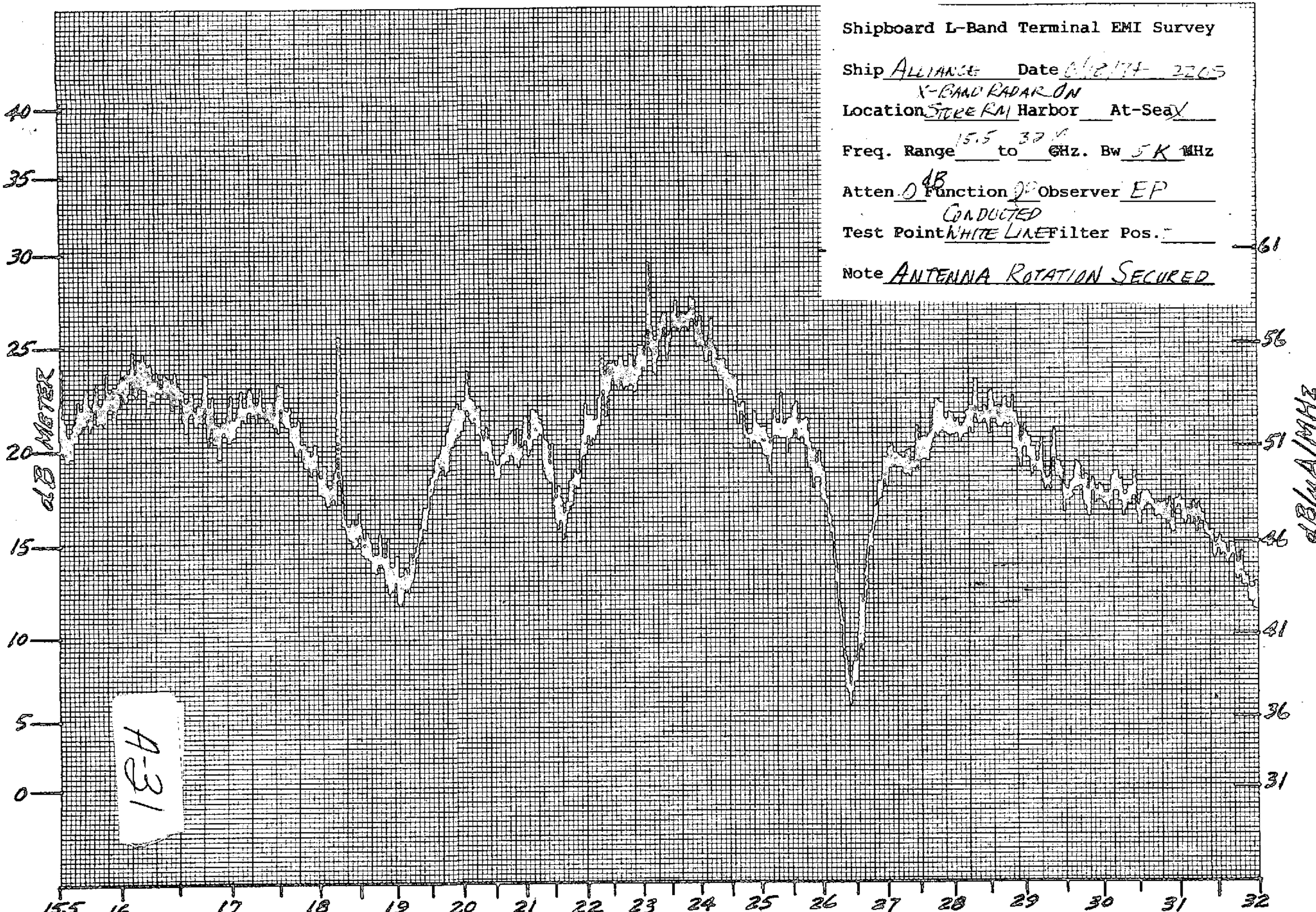
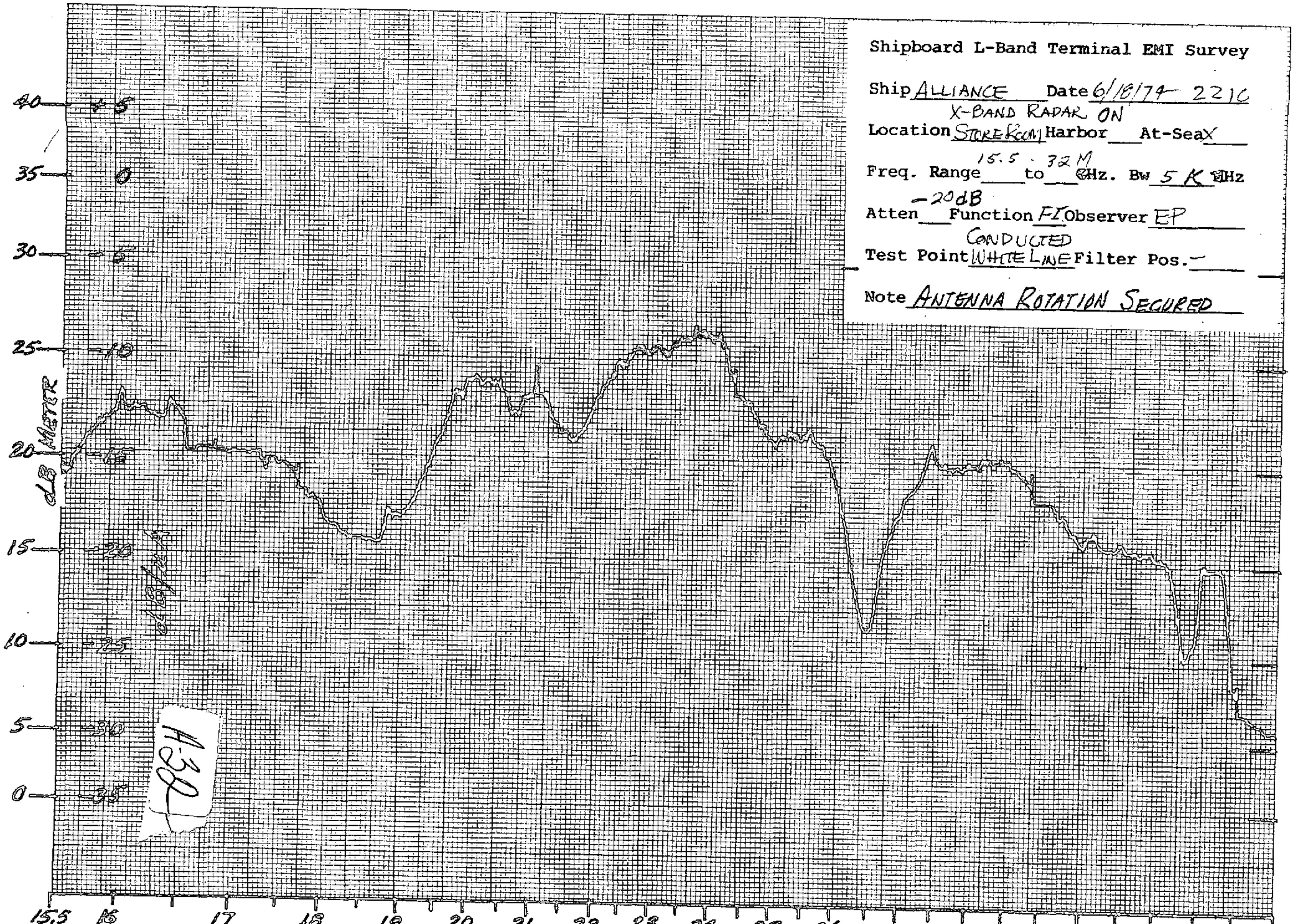
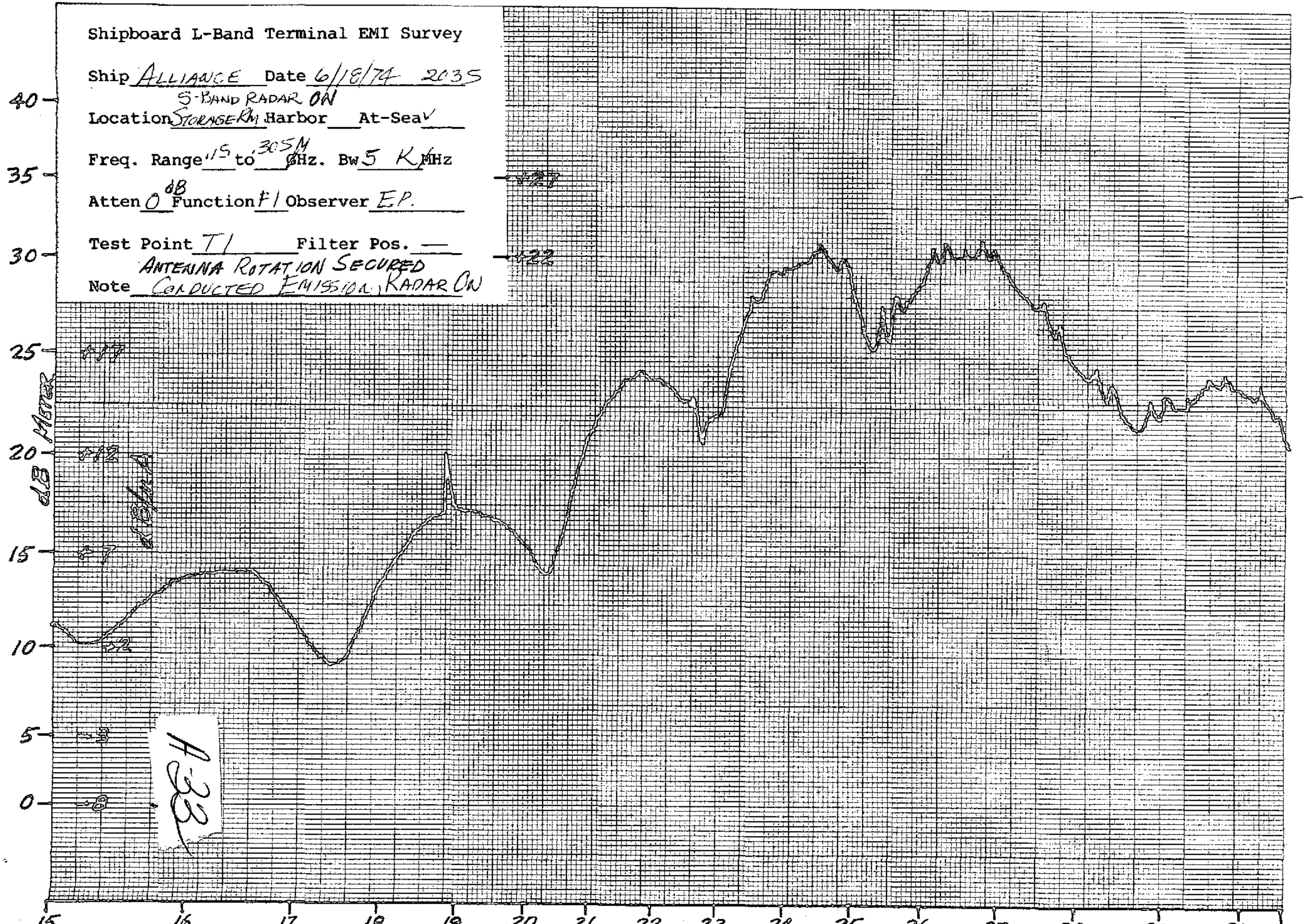

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/12/74 2205
X-BAND RADAR ON
Location STEER RM Harbor At-Sea X
Freq. Range 15.5 to 32 M GHz. Bw 5 K MHz
Atten 0 dB Function QP Observer EP
CONDUCTED
Test Point WHITE LINE Filter Pos. -
Note ANTENNA ROTATION SECURED
40
35
30
25
20
15
10
5
0
dB METER
61
56
51
46
41
36
31
dB/µA/MHz
15.5
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
FREQUENCY—MHz
A-31

CHART A-29


Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2210
X-BAND RADAR ON
Location STORE ROOM Harbor At-Sea X
Freq. Range 15.5 to 32 M GHz. Bw 5 K MHz
Atten -20dB Function FI Observer EP
CONDUCTED
Test Point WHITE LINE Filter Pos. -
Note ANTENNA ROTATION SECURED
dB METER
dB/μV
40 35 30 25 20 15 10 5 0
+5 0 -5 -10 -15 -20 -25 -30 -35
15.5 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
FREQUENCY — MHz
A-32
CHART A-30



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2035
S-BAND RADAR ON
Location STORAGE RM Harbor ___ At-Sea ✓
Freq. Range .15 to .305 M GHz. Bw 5 K MHz
Atten 0 dB Function F1 Observer E.P.
Test Point T1 Filter Pos. —
ANTENNA ROTATION SECURED
Note CONDUCTED EMISSION, RADAR ON
dB METER
dB μA
40
35
30
25
20
15
10
5
0
+27
+22
+17
+12
+7
+2
-3
-8
A-33
.15
.16
.17
.18
.19
.20
.21
.22
.23
.24
.25
.26
.27
.28
.29
.30
.305
FREQUENCY — MHz

CHART A-31

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/12/74 183

Location S-BD RADAR STORAGE ROOM Harbor ___ At-Sea ✓

Freq. Range .15 to .305 MHz. Bw 5 K MHz

Atten 0 dB Function FI Observer [illegible]

Test Point T2 CONDUCTED EMISSION Filter Pos. —

Note S-BAND RADAR ON ANTENNA ROTATION SECURED

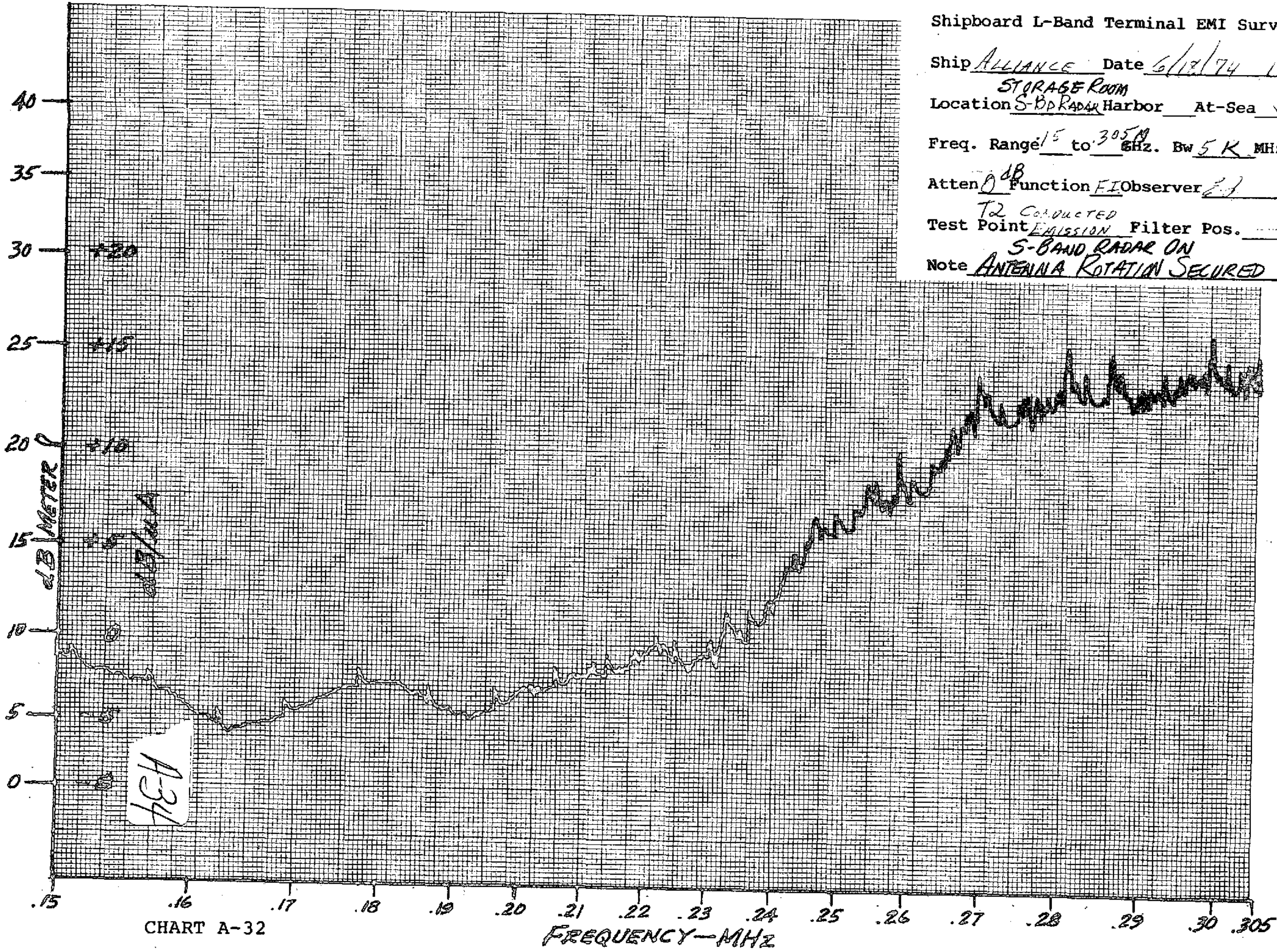


CHART A-32

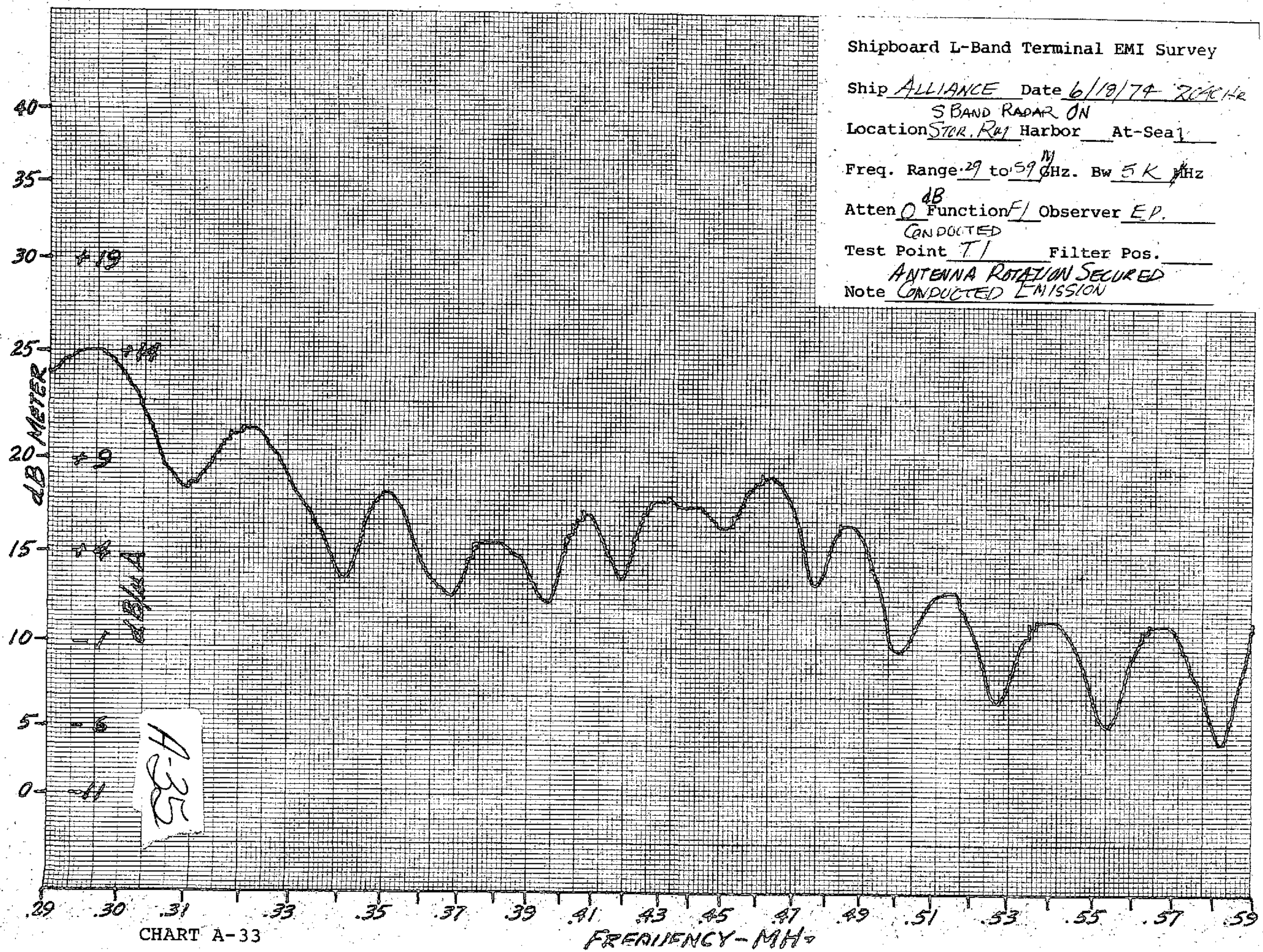

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 2040 Hr
S BAND RADAR ON
Location STGR. RM Harbor At-Sea 1
Freq. Range .29 to .59 MHz. Bw 5 K Hz
Atten 0 dB Function F1 Observer EP.
CONDUCTED
Test Point T1 Filter Pos.
ANTENNA ROTATION SECURED
Note CONDUCTED EMISSION
dB METER
dB/uA
40
35
30 +19
25 +14
20 +9
15 +4
10 -1
5 -6
0 -11
A-35
.29 .30 .31 .33 .35 .37 .39 .41 .43 .45 .47 .49 .51 .53 .55 .57 .59
FREQUENCY-MHz

CHART A-33

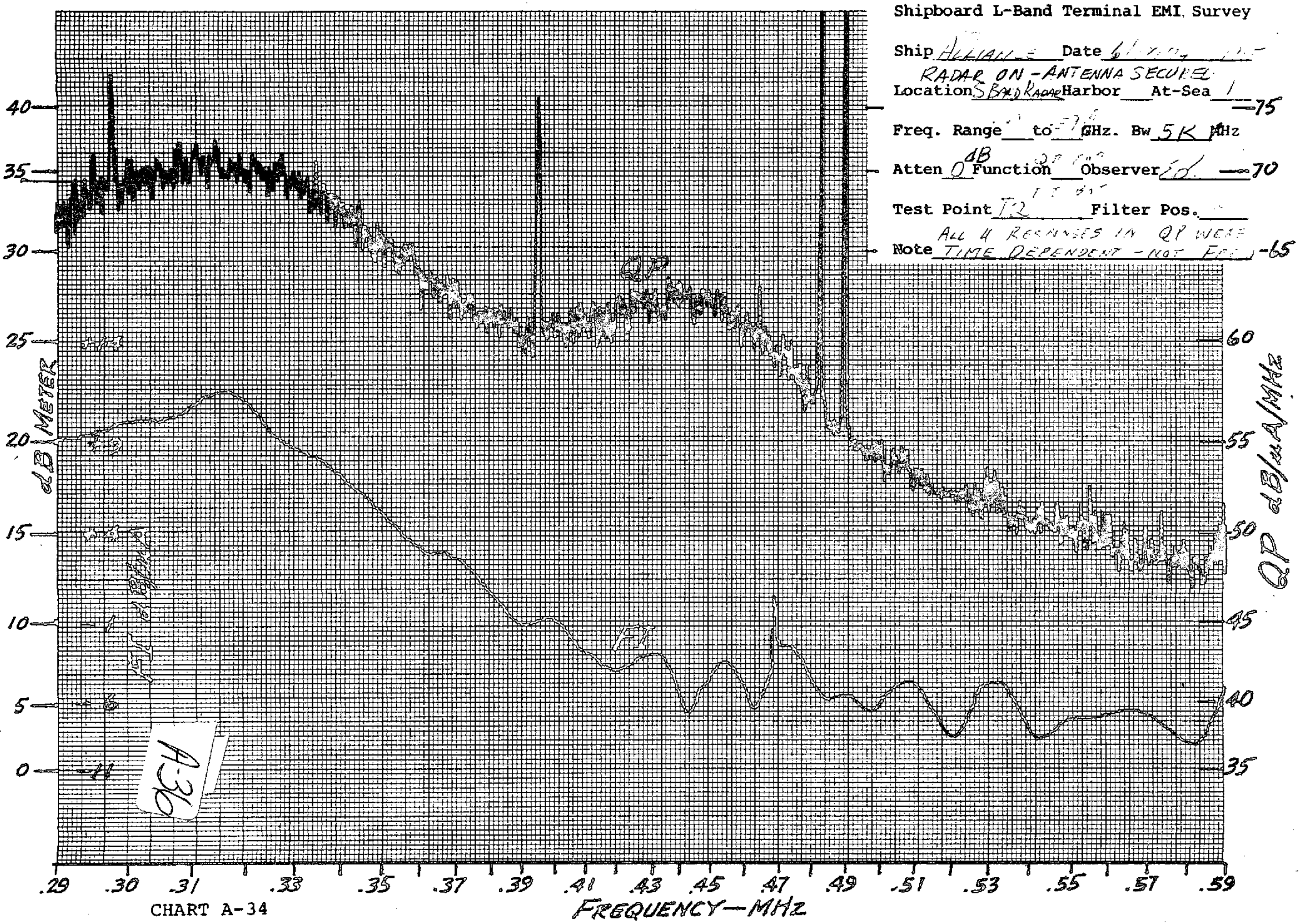

Shipboard L-Band Terminal EMI Survey
Ship
Date
RADAR ON - ANTENNA SECURED
Location S BAND RADAR Harbor At-Sea
Freq. Range to GHz. Bw 5K MHz
Atten 0 dB Function Observer
Test Point
Filter Pos.
Note ALL 4 RESPONSES IN QP WERE TIME DEPENDENT - NOT
QP
PK
dB METER
QP dB/µA/MHz
40
35
30
25
20
15
10
5
0
75
70
65
60
55
50
45
40
35
.29
.30
.31
.33
.35
.37
.39
.41
.43
.45
.47
.49
.51
.53
.55
.57
.59
FREQUENCY—MHz
A-36

CHART A-34

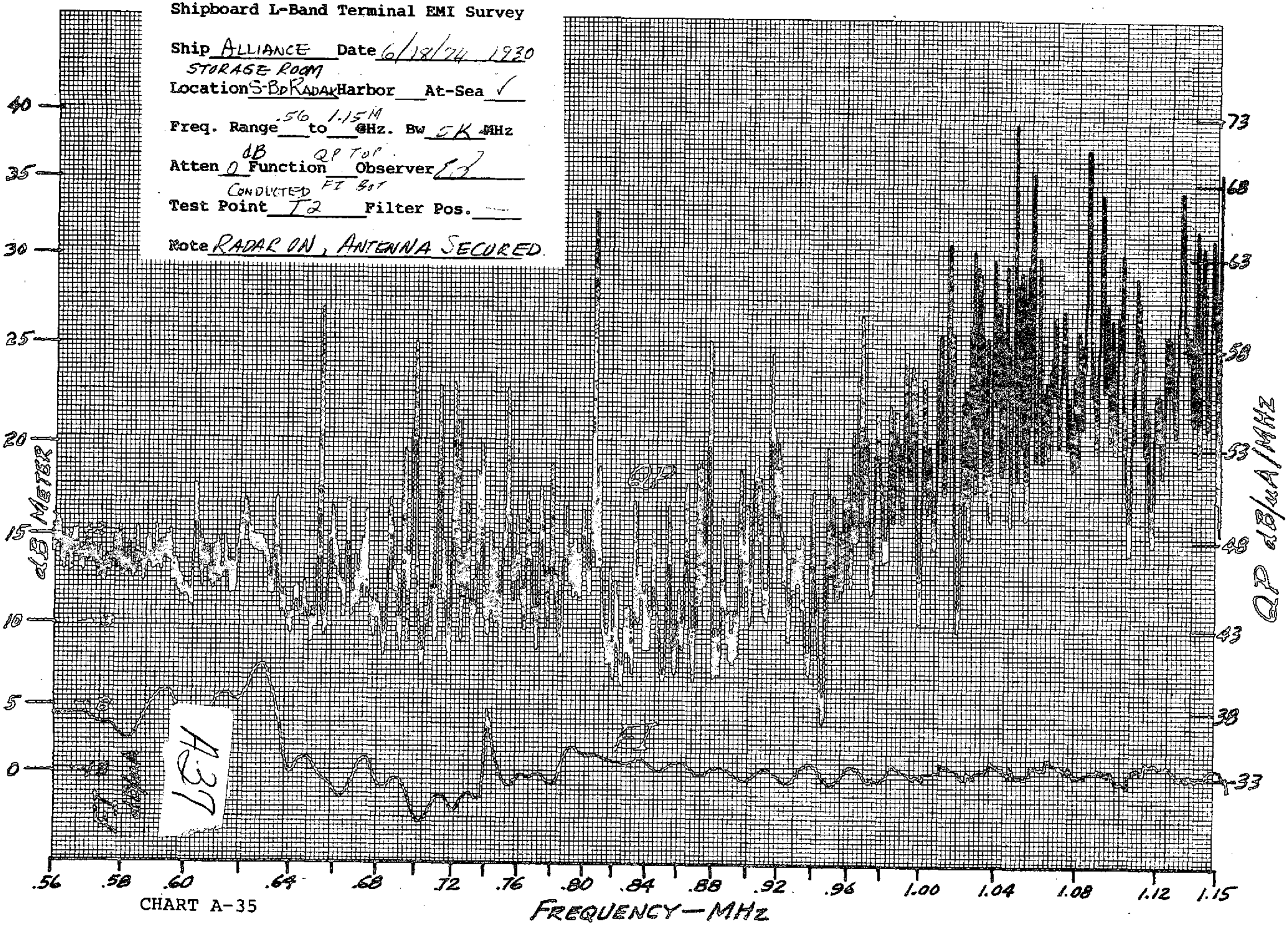

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 1930
STORAGE ROOM
Location S-Bd RADAR Harbor At-Sea ✓
Freq. Range .56 to 1.15M GHz. Bw 5K MHz
Atten 0 dB Function QP TOP FI BOT Observer
CONDUCTED
Test Point T2 Filter Pos. —
Note RADAR ON, ANTENNA SECURED
40
35
30
25
20
15
10
5
0
dB METER
73
68
63
58
53
48
43
38
33
QP dB/μA/MHz
QP
FI
437
.56
.58
.60
.64
.68
.72
.76
.80
.84
.88
.92
.96
1.00
1.04
1.08
1.12
1.15
FREQUENCY—MHz

CHART A-35

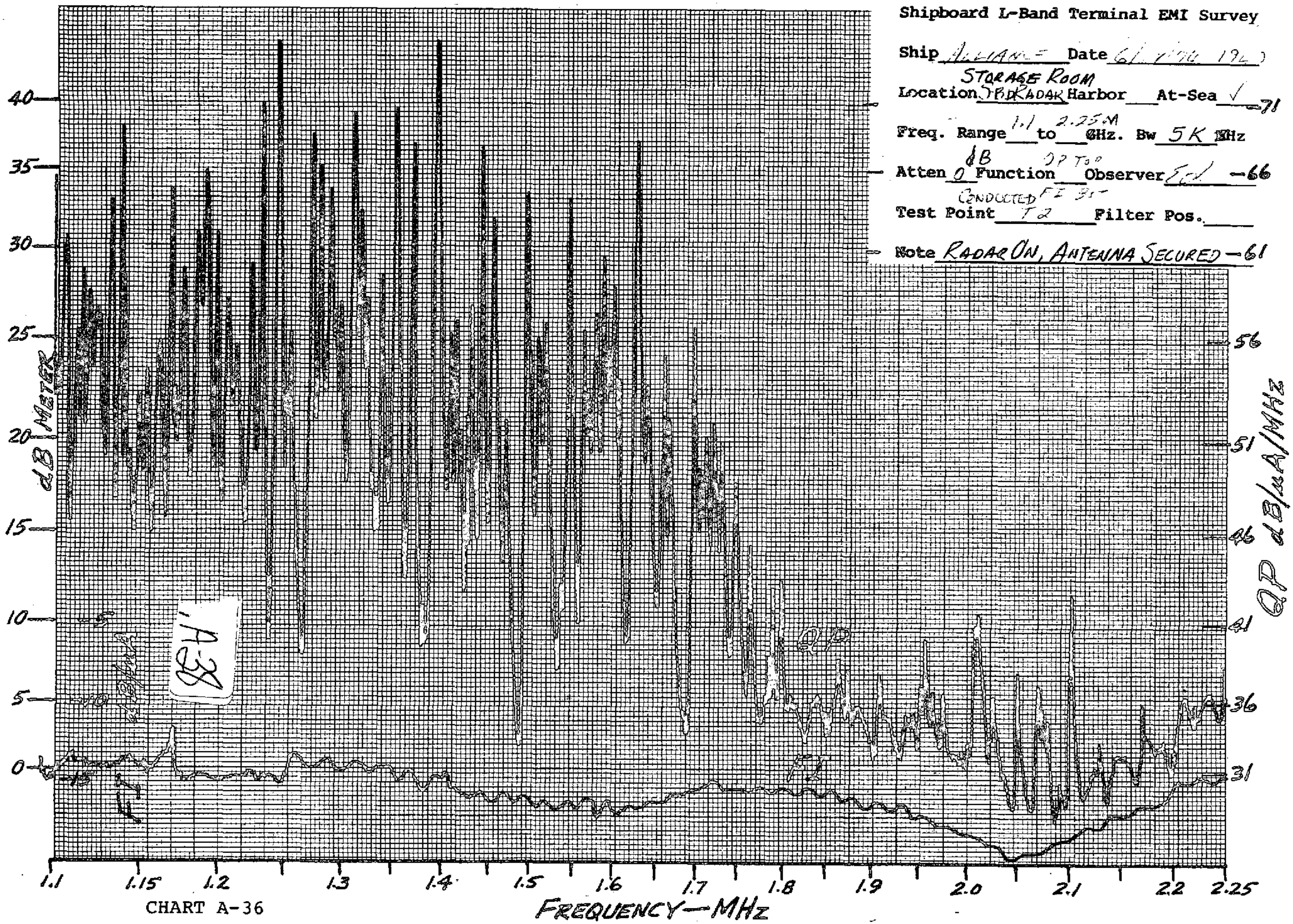

Shipboard L-Band Terminal EMI Survey
Ship
Date
STORAGE ROOM
Location
Harbor
At-Sea ✓
Freq. Range 1.1 to 2.25M GHz. Bw 5K
Atten 0 dB
Function QP
Observer
CONDUCTED
Test Point T2
Filter Pos.
Note RADAR ON, ANTENNA SECURED
dB METER
QP dB/μA/MHz
QP
A-38
40
35
30
25
20
15
10
5
0
71
66
61
56
51
46
41
36
31
1.1
1.15
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.25
FREQUENCY—MHz

CHART A-36

C-2

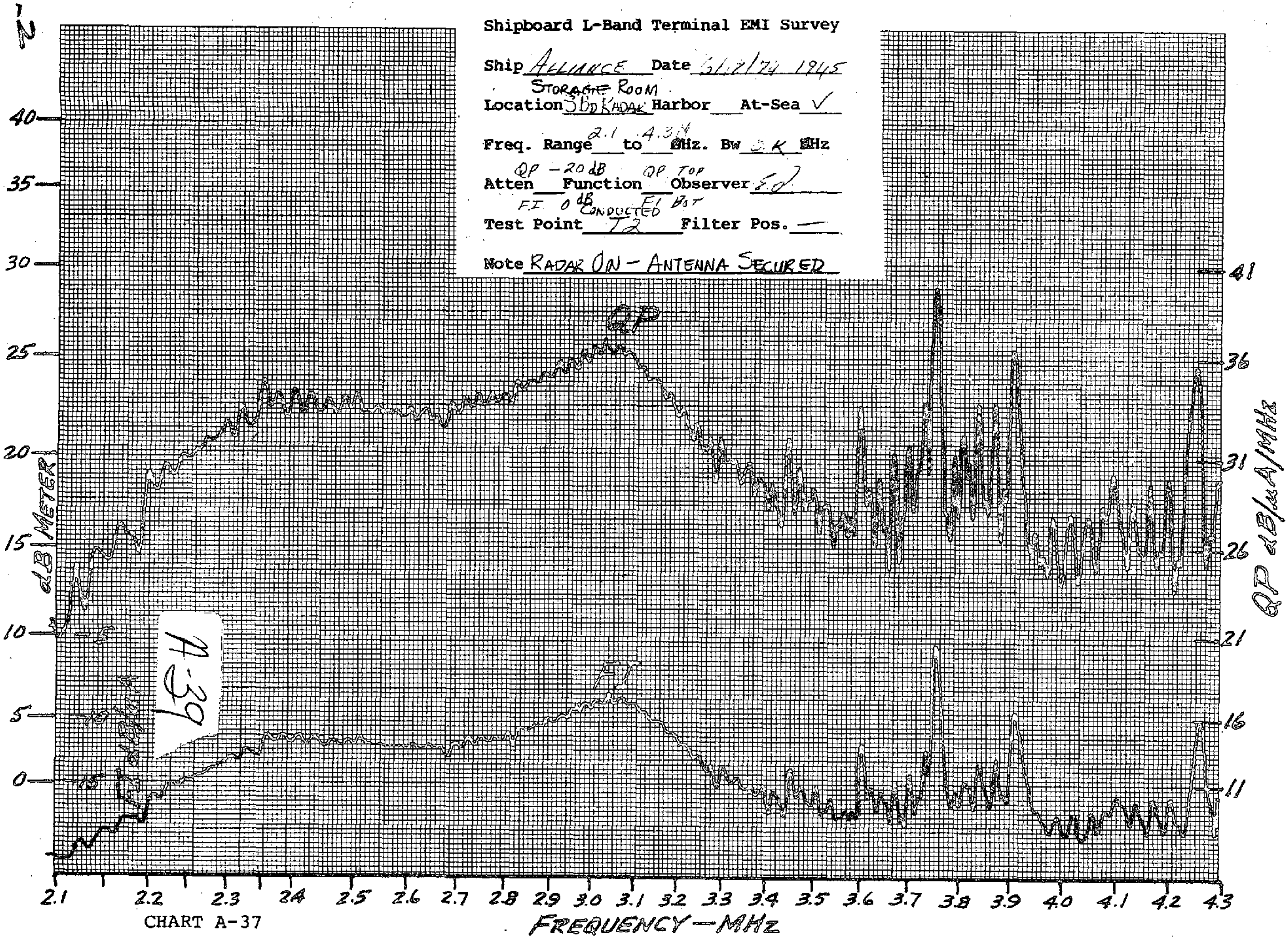

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/12/74 1945
Location STORAGE ROOM SBD RADAR Harbor At-Sea ✓
Freq. Range 2.1 to 4.3 MHz. Bw 3 K Hz
Atten QP -20 dB FI 0 dB Function QP TOP FI BOT CONDUCTED Observer
Test Point T2 Filter Pos. —
Note RADAR ON - ANTENNA SECURED
QP
FI
dB METER
QP dB/μA/MHz
A-39
FREQUENCY—MHz

CHART A-37

KEUFFEL & ESSER CO.

Shipboard L-Band Terminal EMI Survey

Ship [illegible] Date 6/17/94 [illegible]

Location STORAGE ROOM STBD RADAR Harbor ___ At-Sea ✓

Freq. Range 4.1 to 8.4 MHz. Bw 5 K MHz

Atten -20 dB Function F.I. Observer [illegible]

Test Point T2 CONDUCTED Filter Pos. —

Note RADAR ON - ANTENNA SECURED

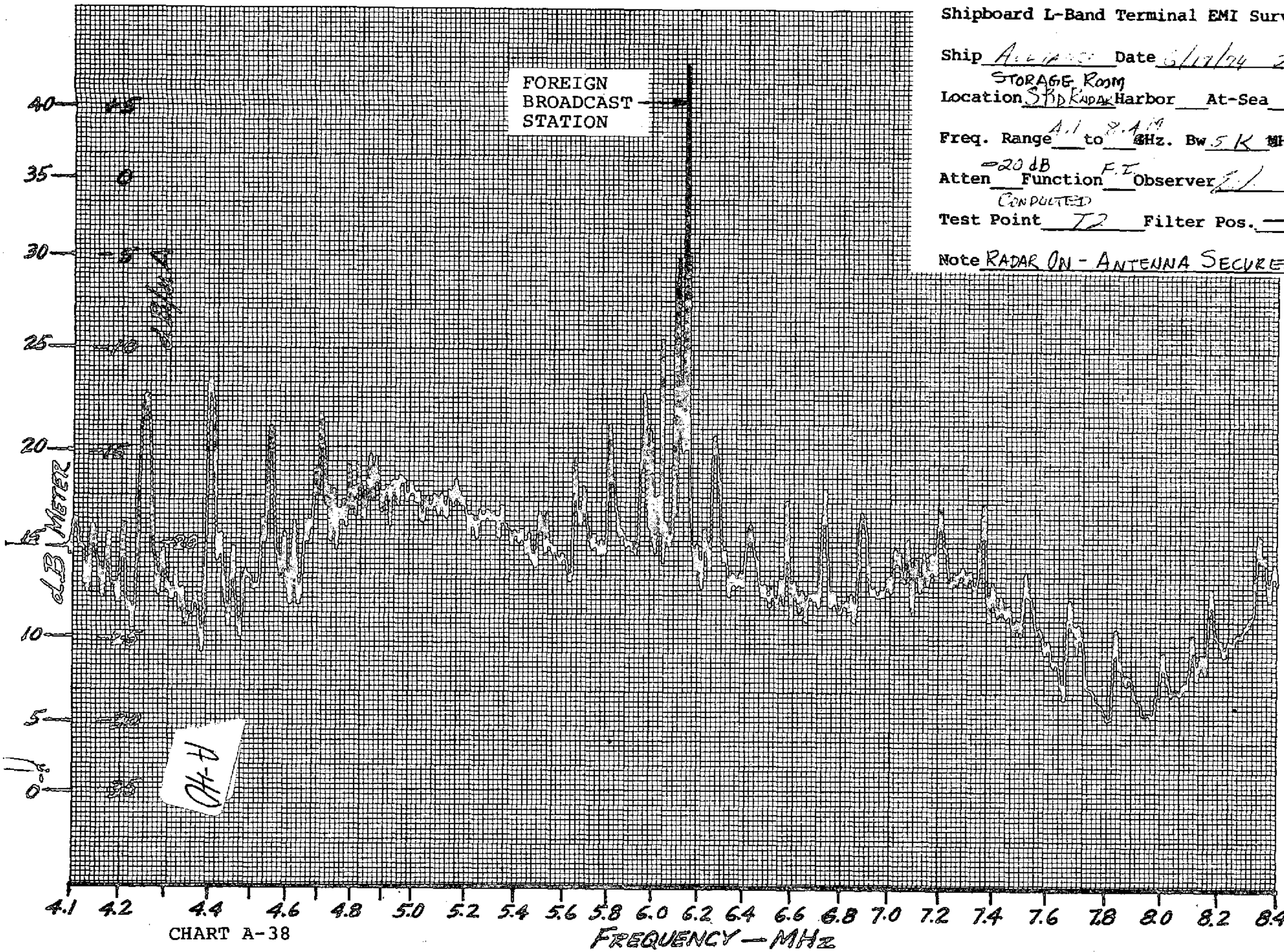


CHART A-38

18 X 25 KEUFFEL & ESSER CO. MADE IN U.S.A.

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date

Location STORAGE ROOM SBD RADAR Harbor ___ At-Sea /

Freq. Range 4.1 to ___ GHz. Bw 1K MHz

Atten 0 dB Function QP Observer Ed

Test Point T2 CONDUCTED Filter Pos. ___

Note RADAR ON - ANTENNA SECURED

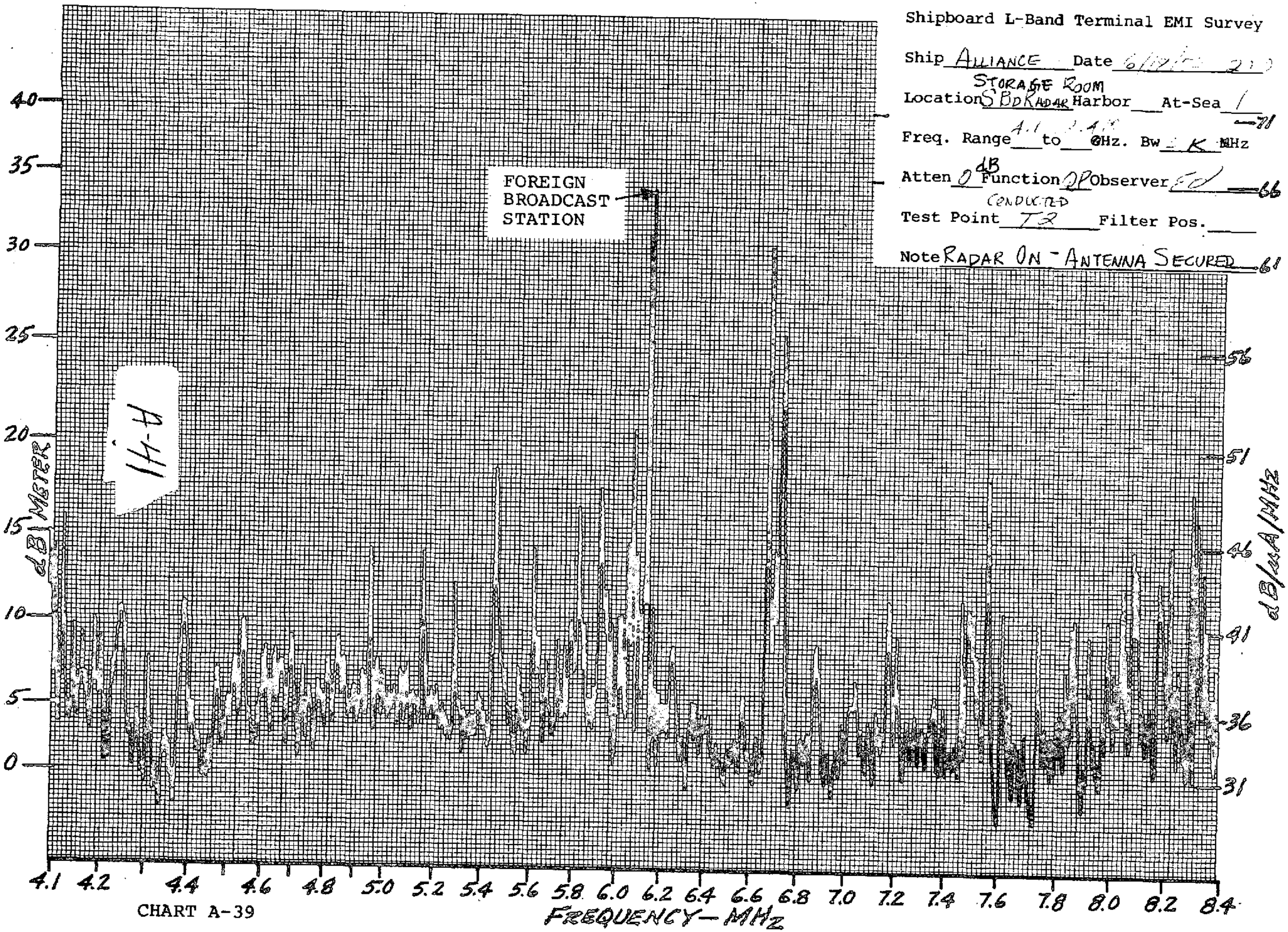
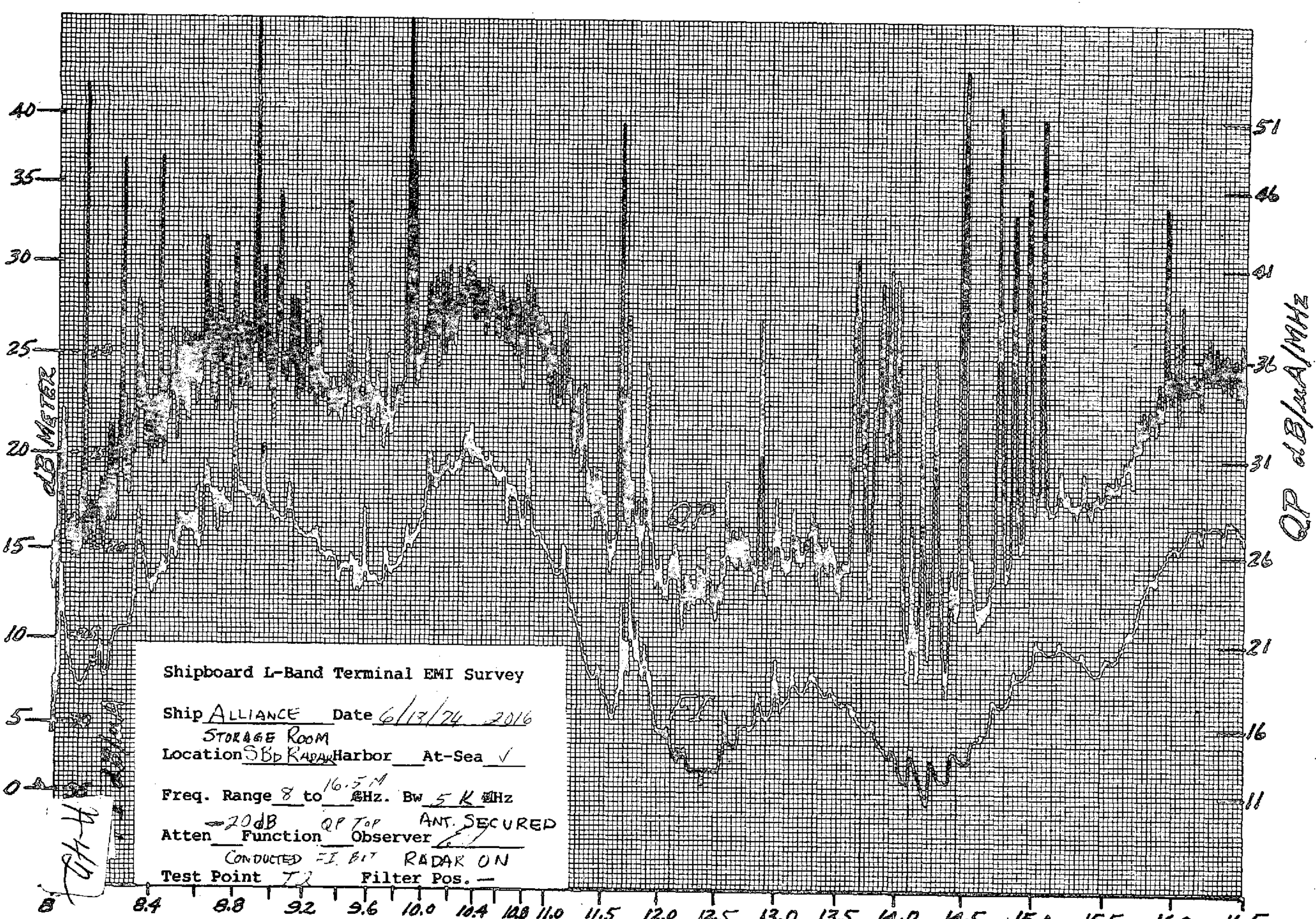


CHART A-39



101
18 X 25 CM.
KEUFFEL & ESSER CO.
MADE IN U.S.A.
dB METER
QP dB/μA/MHz
QP
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/13/74 2016
STORAGE ROOM
Location SBD RADAR Harbor At-Sea ✓
Freq. Range 8 to 16.5 MHz. Bw 5 K Hz
-20dB QP TOP ANT. SECURED
Atten Function Observer
CONDUCTED FI BIT RADAR ON
Test Point T2 Filter Pos. —
8 8.4 8.8 9.2 9.6 10.0 10.4 10.8 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5
FREQUENCY—MHz

CHART A-40

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/18/74 2000

Location STORAGE ROOM S-Bd RADAR Harbor ___ At-Sea ✓

Freq. Range 15.5 to 32 MHz. Bw 5 K MHz

Atten -20 dB Function QP TOP Observer ___

Test Point T2 CONDUCTED FT BOT Filter Pos. ___

Note RADAR ON - ANTENNA SECURED

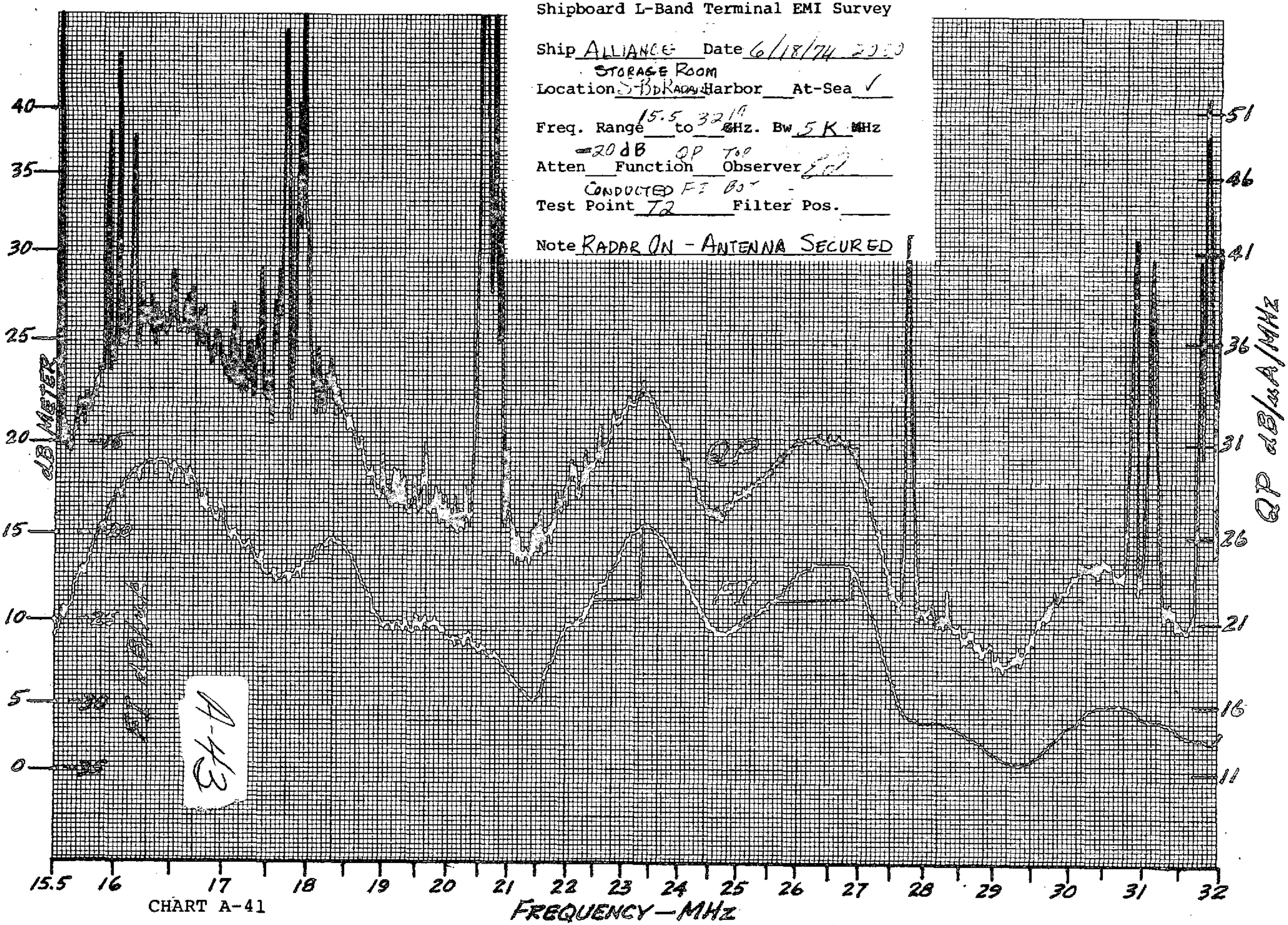


CHART A-41

KEUFFEL & ESSER CO.

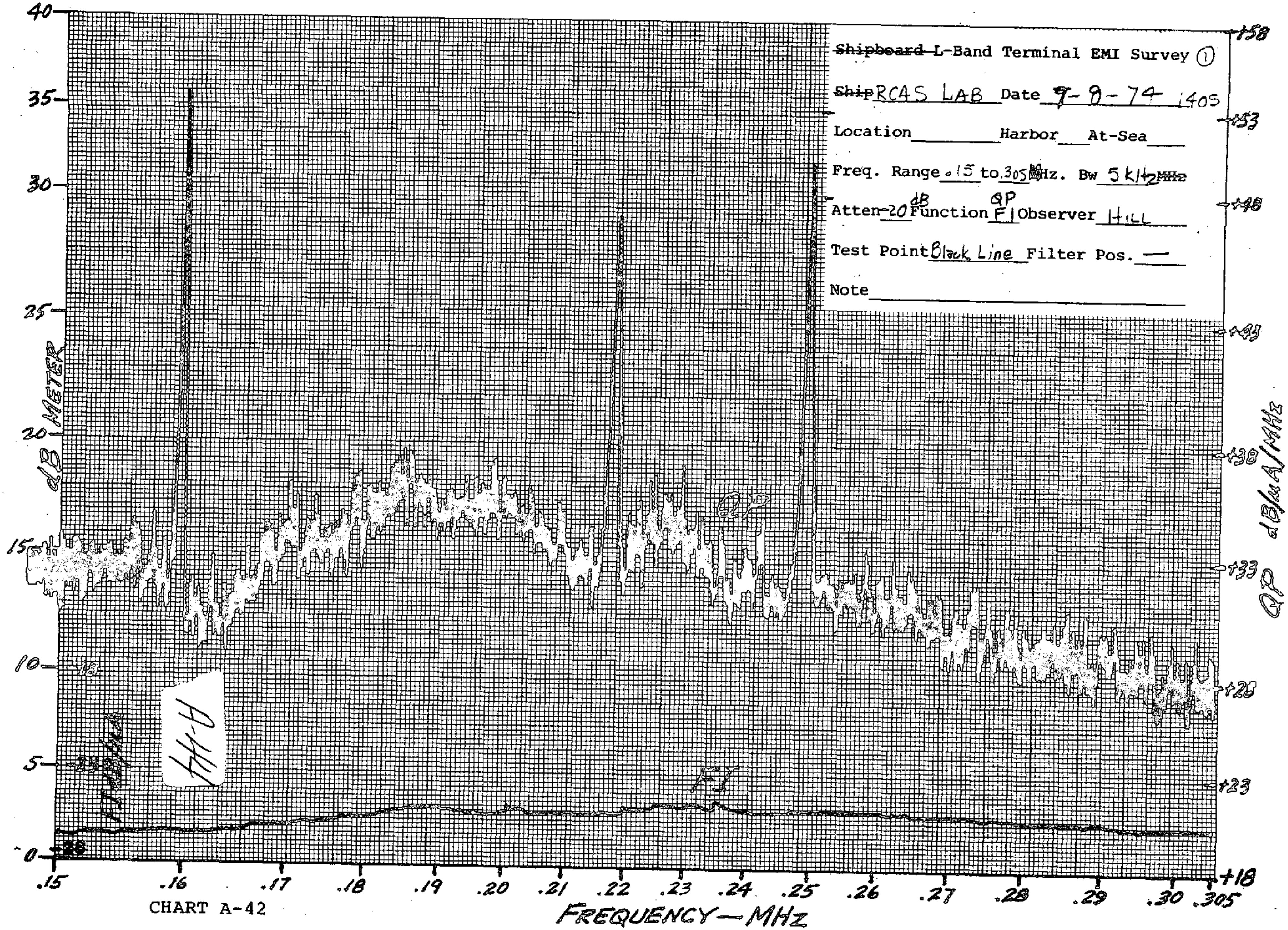


CHART A-42

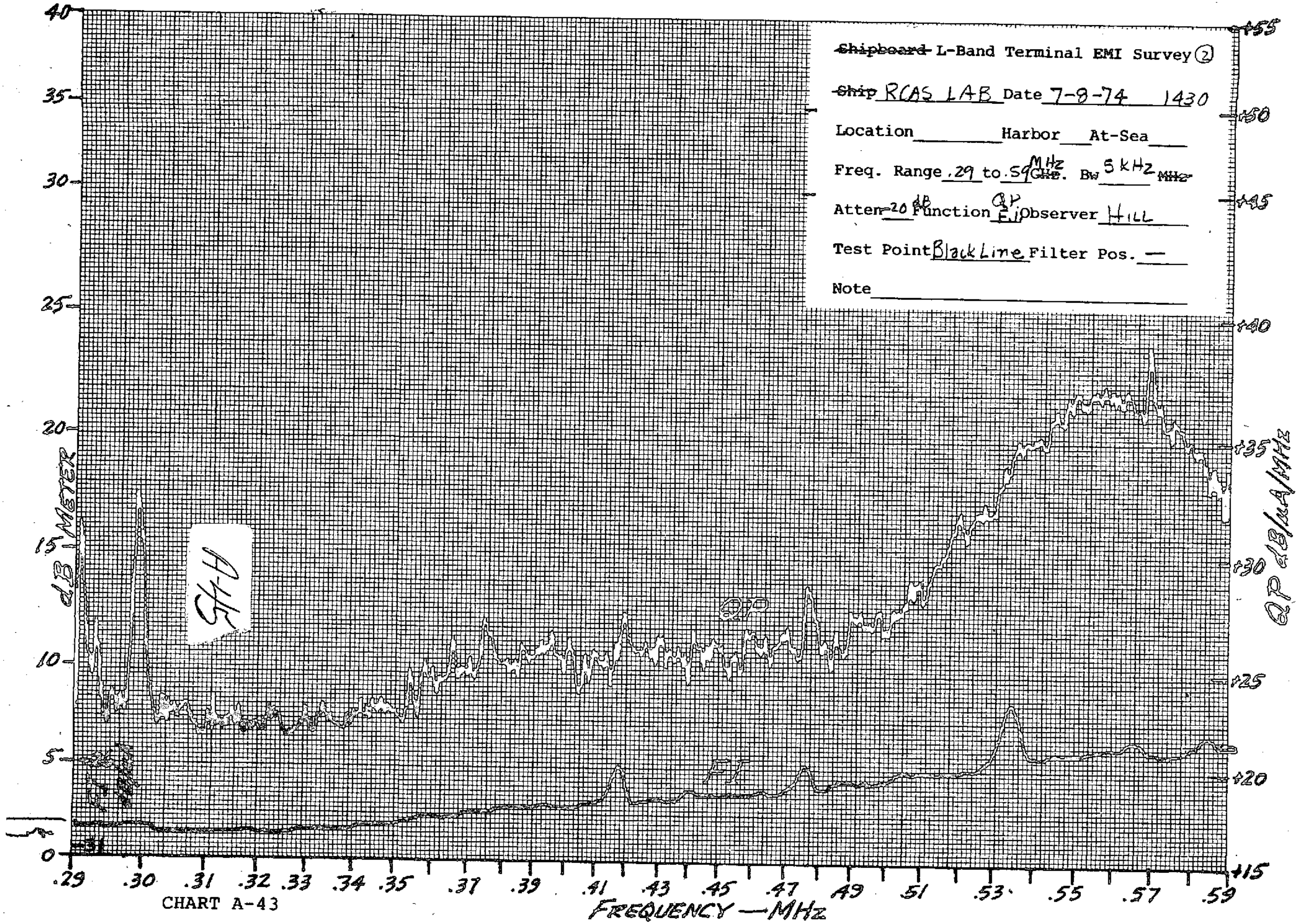

~~Shipboard~~ L-Band Terminal EMI Survey (2)
~~Ship~~ RCAS LAB Date 7-8-74 1430
Location ______ Harbor ___ At-Sea ___
Freq. Range .29 to .59 MHz Bw 5 kHz
Atten 20 dB Function QP E.I. Observer HILL
Test Point Black Line Filter Pos. —
Note ______
SH-H
QP
FI
dB / METER
QP dB/uA/MHz
FREQUENCY — MHz
40
35
30
25
20
15
10
5
0
+55
+50
+45
+40
+35
+30
+25
+20
+15
.29
.30
.31
.32
.33
.34
.35
.37
.39
.41
.43
.45
.47
.49
.51
.53
.55
.57
.59

CHART A-43

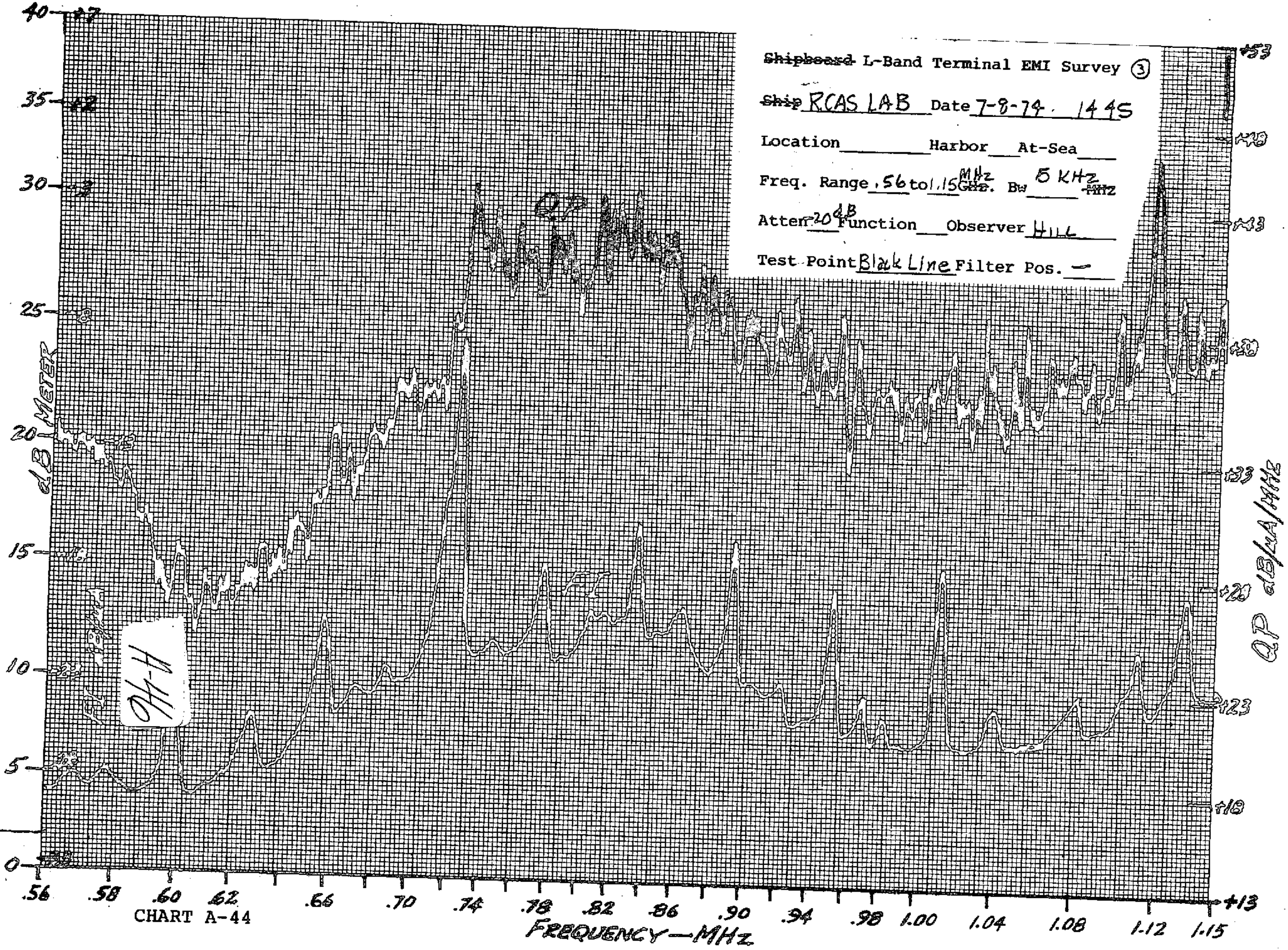
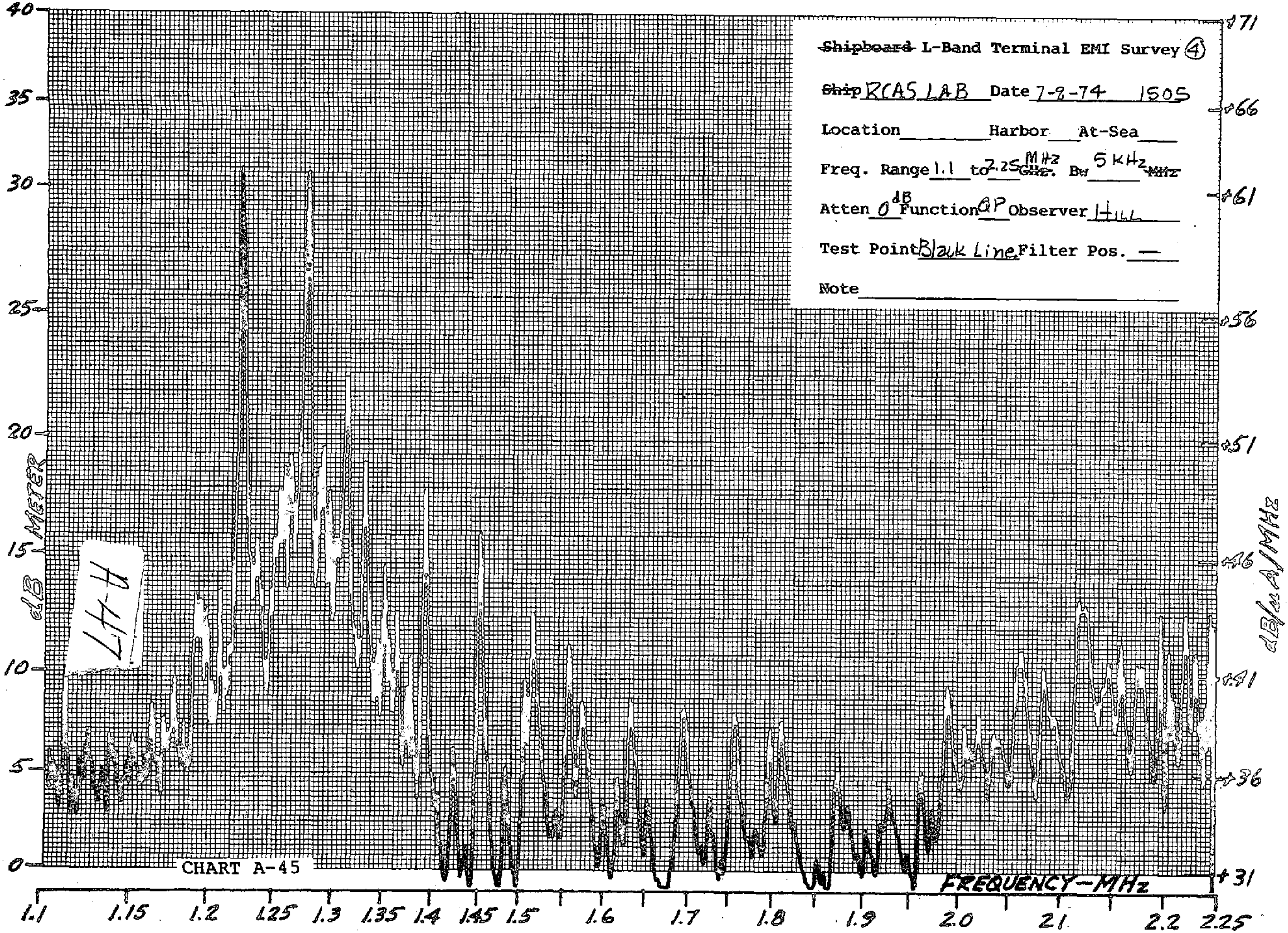
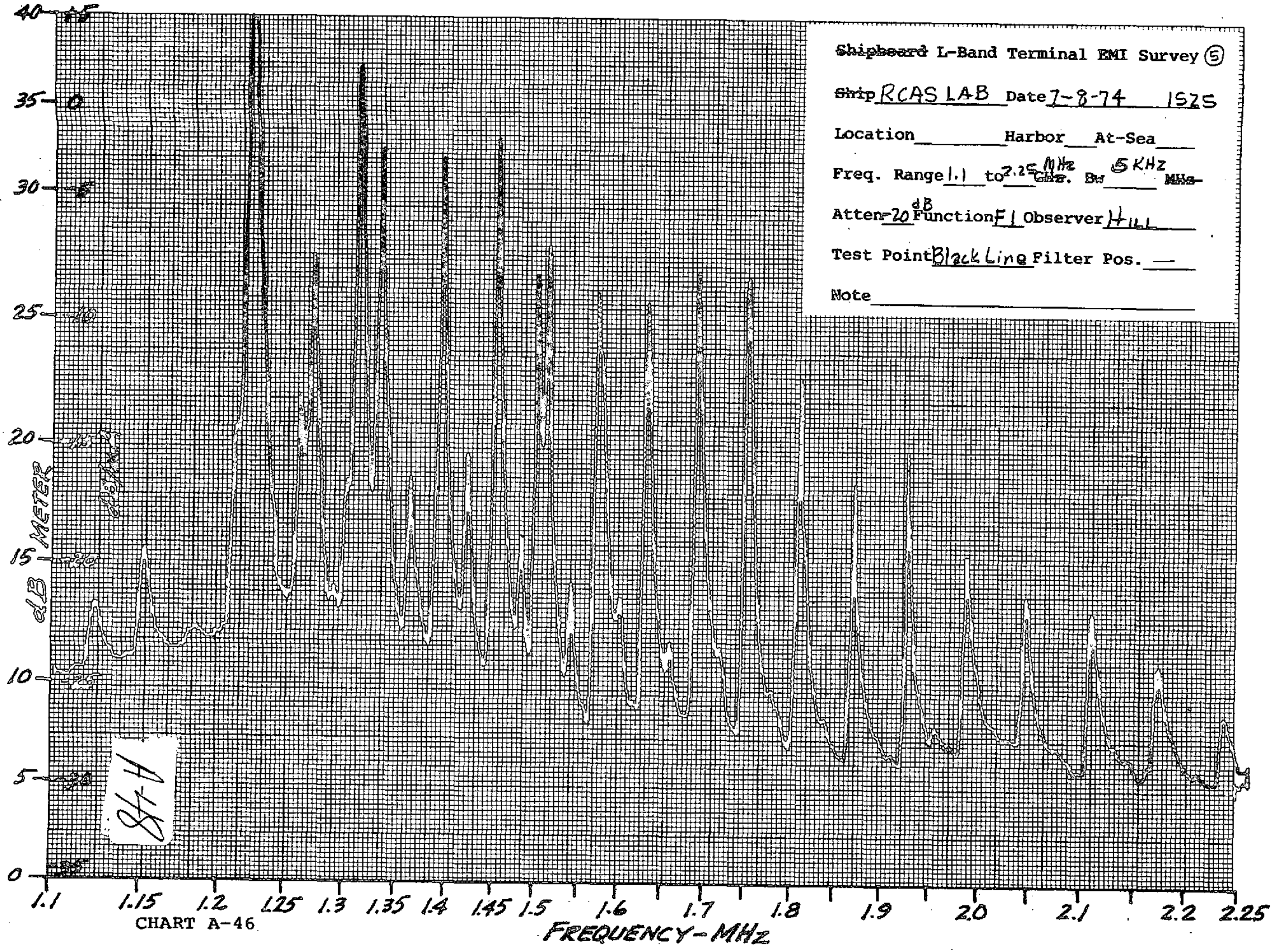
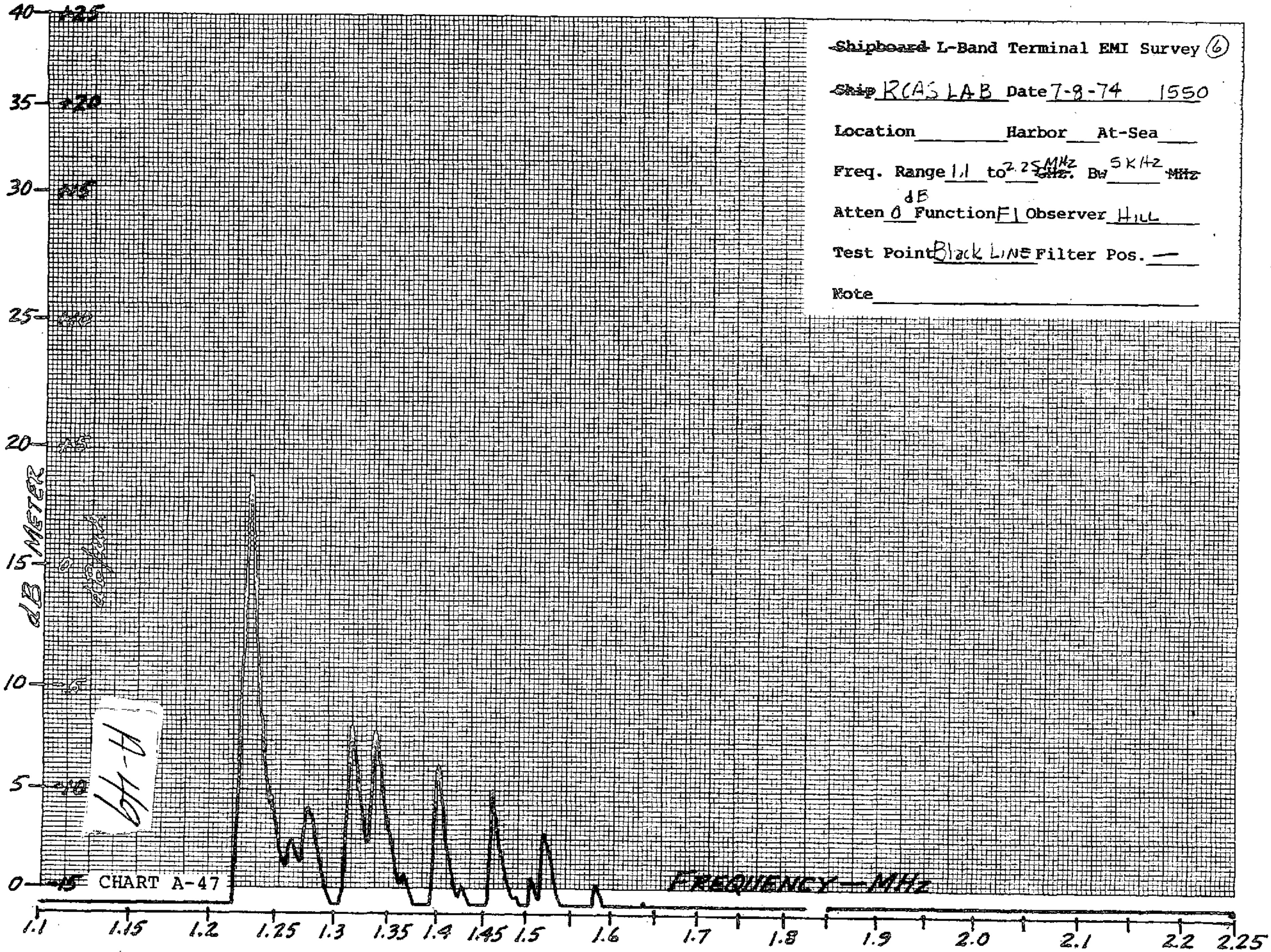

~~Shipboard~~ L-Band Terminal EMI Survey ③
~~Ship~~ RCAS LAB Date 7-8-74. 1445
Location Harbor At-Sea
Freq. Range .56 to 1.15 MHz Bw 5 KHz
Atten 20 dB Function Observer HILL
Test Point Blak Line Filter Pos. —
QP
dB METER
QP dB/μA/MHz
H-40
FREQUENCY—MHz
.56
.58
.60
.62
.66
.70
.74
.78
.82
.86
.90
.94
.98
1.00
1.04
1.08
1.12
1.15
40
35
30
25
20
15
10
5
0
+53
+48
+43
+38
+33
+28
+23
+18
+13

CHART A-44

KEUFFEL & ESSER CO.




Shipboard L-Band Terminal EMI Survey (5)
Ship RCAS LAB Date 7-8-74 1525
Location ______ Harbor ___ At-Sea ___
Freq. Range 1.1 to 2.25 MHz GHz. Bw 5 KHz MHz
Atten 20 dB Function F1 Observer Hill
Test Point Black Line Filter Pos. —
Note
dB METER
FREQUENCY - MHz
0
5
10
15
20
25
30
35
40
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.25
A-48
CHART A-46


~~Shipboard~~ L-Band Terminal EMI Survey 6
~~Ship~~ RCAS LAB Date 7-8-74 1550
Location Harbor At-Sea
Freq. Range 1.1 to 2.25 MHz ~~GHz~~. Bw 5 KHz ~~MHz~~
Atten 0 dB Function F1 Observer HILL
Test Point Black LINE Filter Pos. —
Note
dB METER
CHART A-47
A-49
FREQUENCY — MHz
40
35
30
25
20
15
10
5
0
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.25

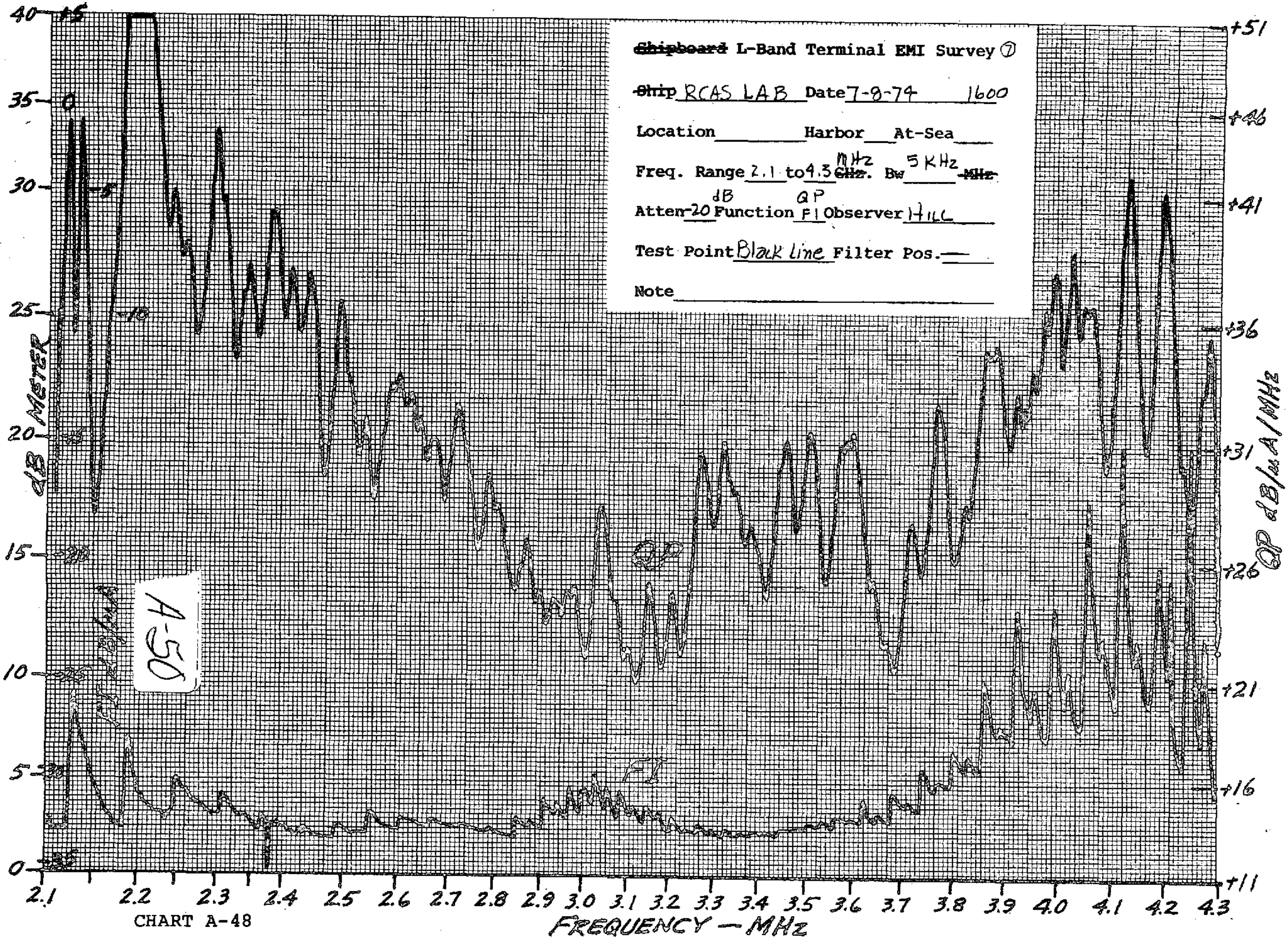

~~Shipboard~~ L-Band Terminal EMI Survey ⑦
~~Ship~~ RCAS LAB Date 7-8-74 1600
Location Harbor At-Sea
Freq. Range 2.1 to 4.3 MHz ~~GHz~~. Bw 5 KHz ~~MHz~~
Atten 20 dB Function QP FI Observer Hill
Test Point Black line Filter Pos. —
Note
dB METER
QP dB/µA/MHz
QP
FI
FI dB/µA/MHz
A-50
FREQUENCY — MHz
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0
4.1
4.2
4.3
40
35
30
25
20
15
10
5
0
+5
0
-5
-10
-15
-20
-25
-30
-35
+51
+46
+41
+36
+31
+26
+21
+16
+11

CHART A-48

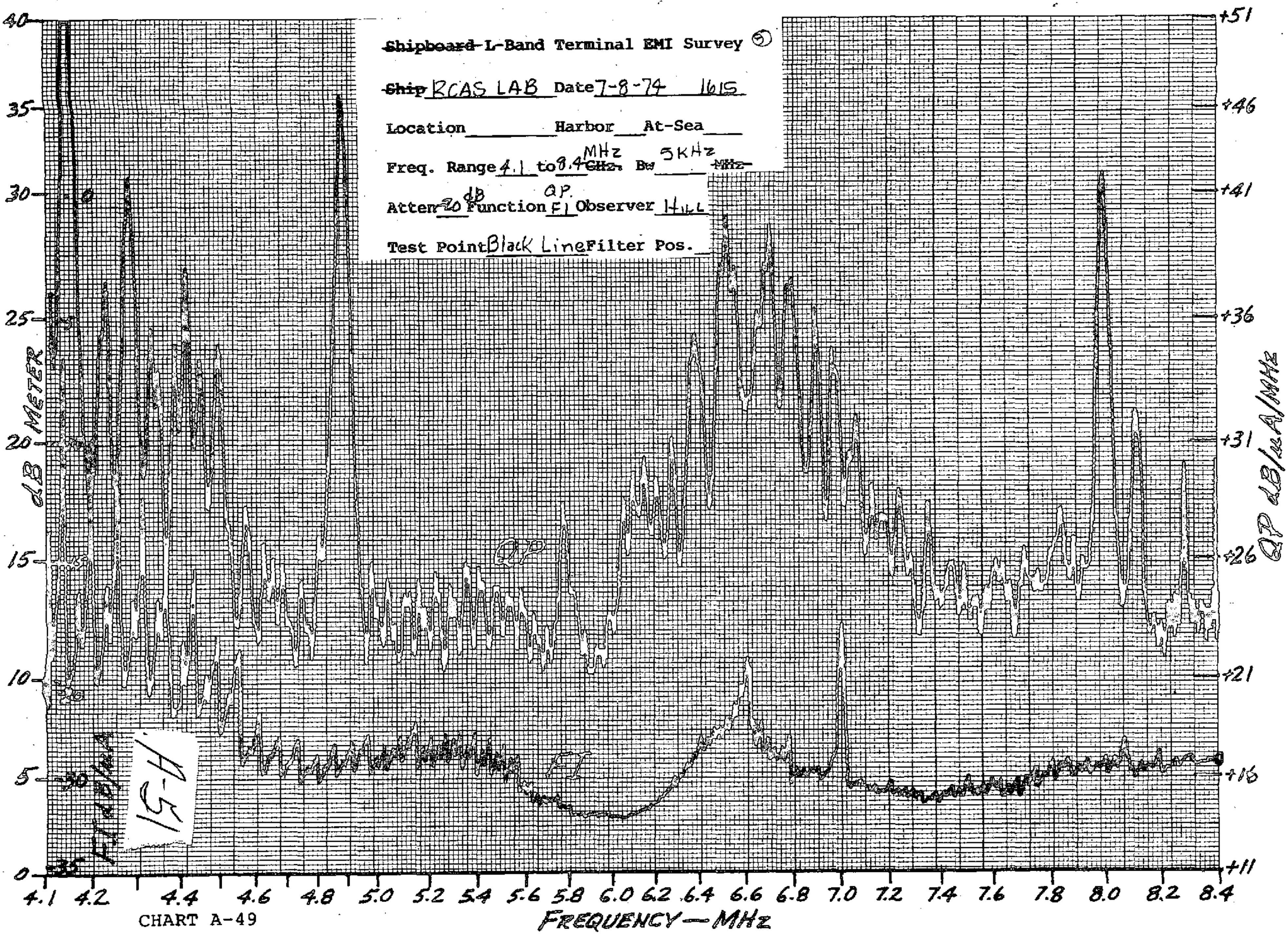
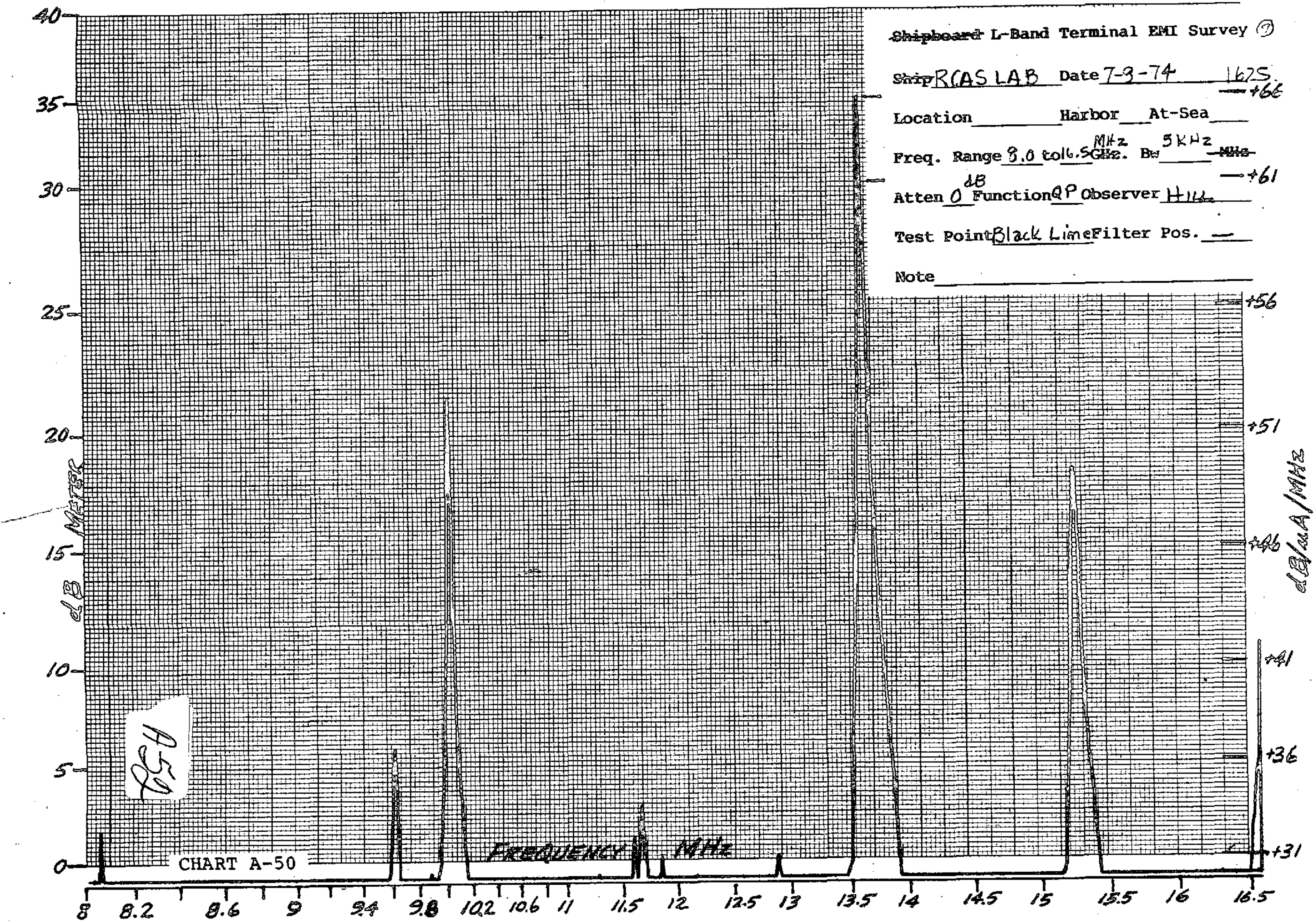

~~Shipboard~~ L-Band Terminal EMI Survey ⑤
~~Ship~~ RCAS LAB Date 7-8-74 1615
Location ____ Harbor ___ At-Sea ___
Freq. Range 4.1 to 8.4 MHz ~~GHz.~~ Bw 5KHz ~~MHz~~
Atten 20 dB Function QP. FI Observer Hill
Test Point Black Line Filter Pos. ___
dB METER
QP dB/μA/MHz
FI dB/μA
15-H
QP
FI
40
35
30
25
20
15
10
5
0
-30
-35
+51
+46
+41
+36
+31
+26
+21
+16
+11
4.1
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
FREQUENCY—MHz

CHART A-49

KEUFFEL & ESSER CO.



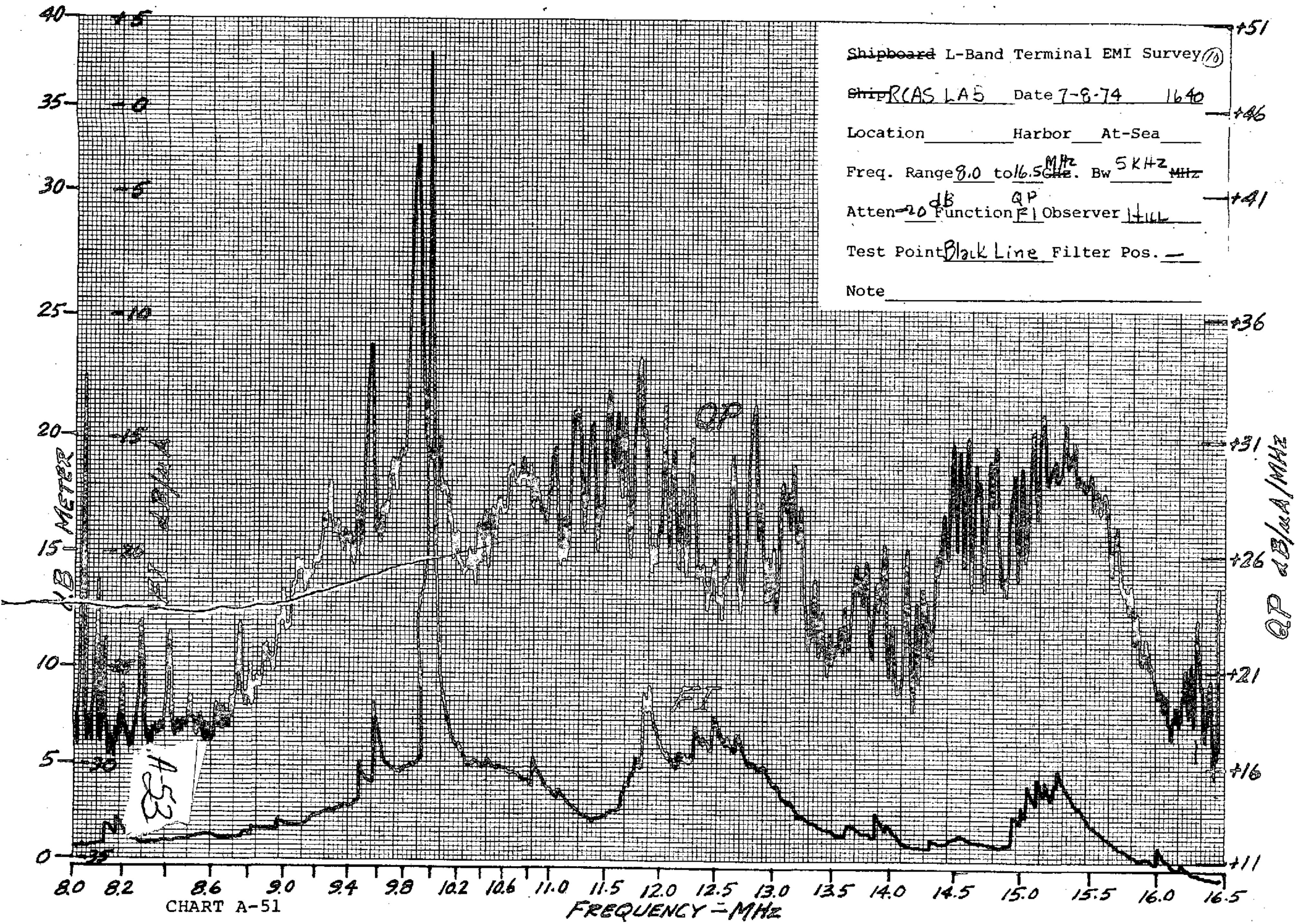
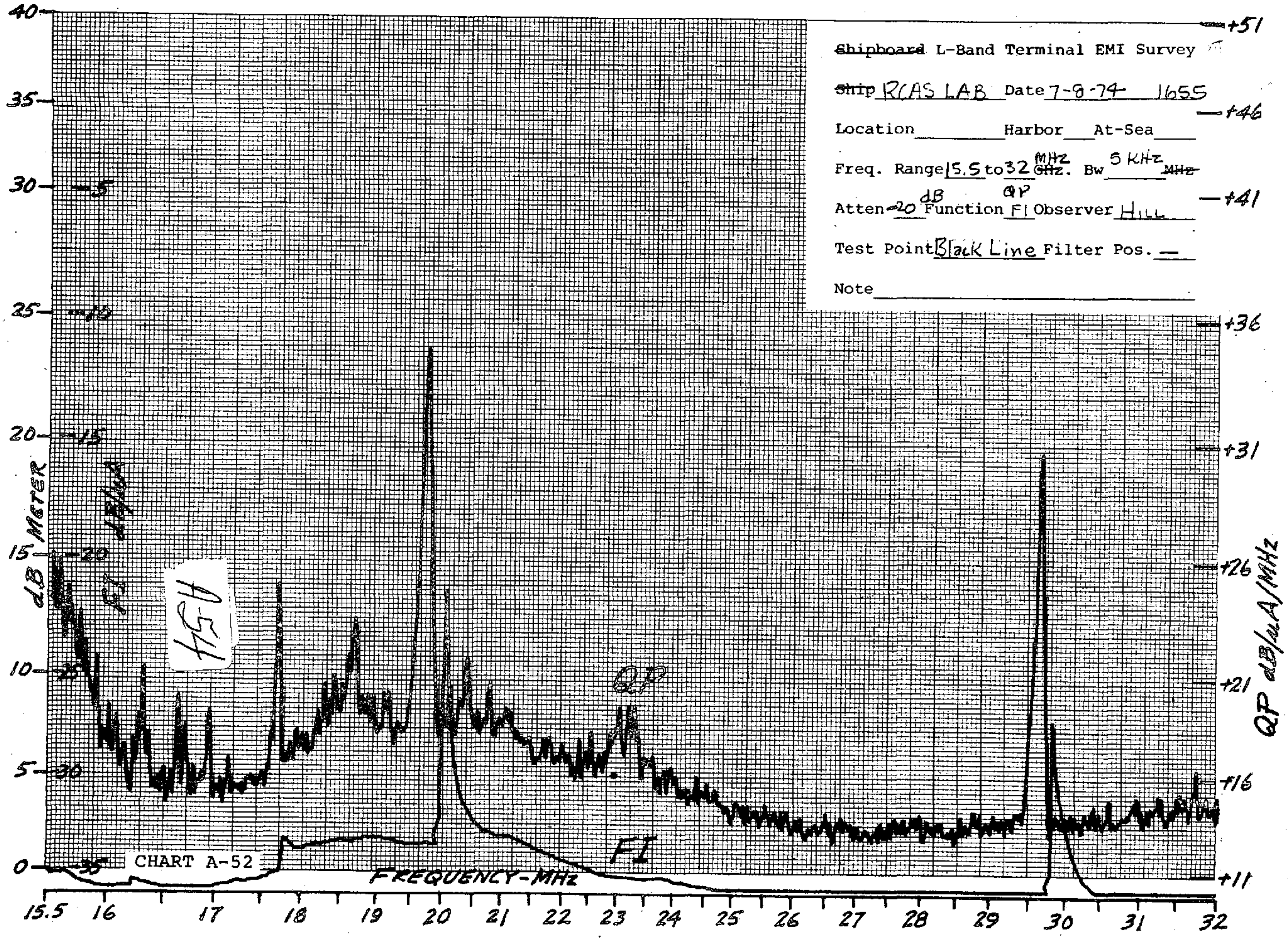

Shipboard L-Band Terminal EMI Survey (10)
Ship RCAS LA5 Date 7-8-74 1640
Location Harbor At-Sea
Freq. Range 8.0 to 16.5 MHz. Bw 5 KHz
Atten 20 dB Function QP Observer Hill
Test Point Black Line Filter Pos. —
Note
dB METER
FI dB/uA
QP dB/uA/MHz
QP
FI
A-53
40
35
30
25
20
15
10
5
0
+5
0
-5
-10
-15
-20
-25
-30
-35
+51
+46
+41
+36
+31
+26
+21
+16
+11
8.0
8.2
8.6
9.0
9.4
9.8
10.2
10.6
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
FREQUENCY - MHz

CHART A-51

KEUFFEL & ESSER CO.



#21101

CALIBRATING ENGINEER: L. WOLF

DATE: 5-26-61

CURRENT PROBE 91550-1

SERIAL NO. 345-131

STODDART AIRCRAFT RADIO CO., INC.

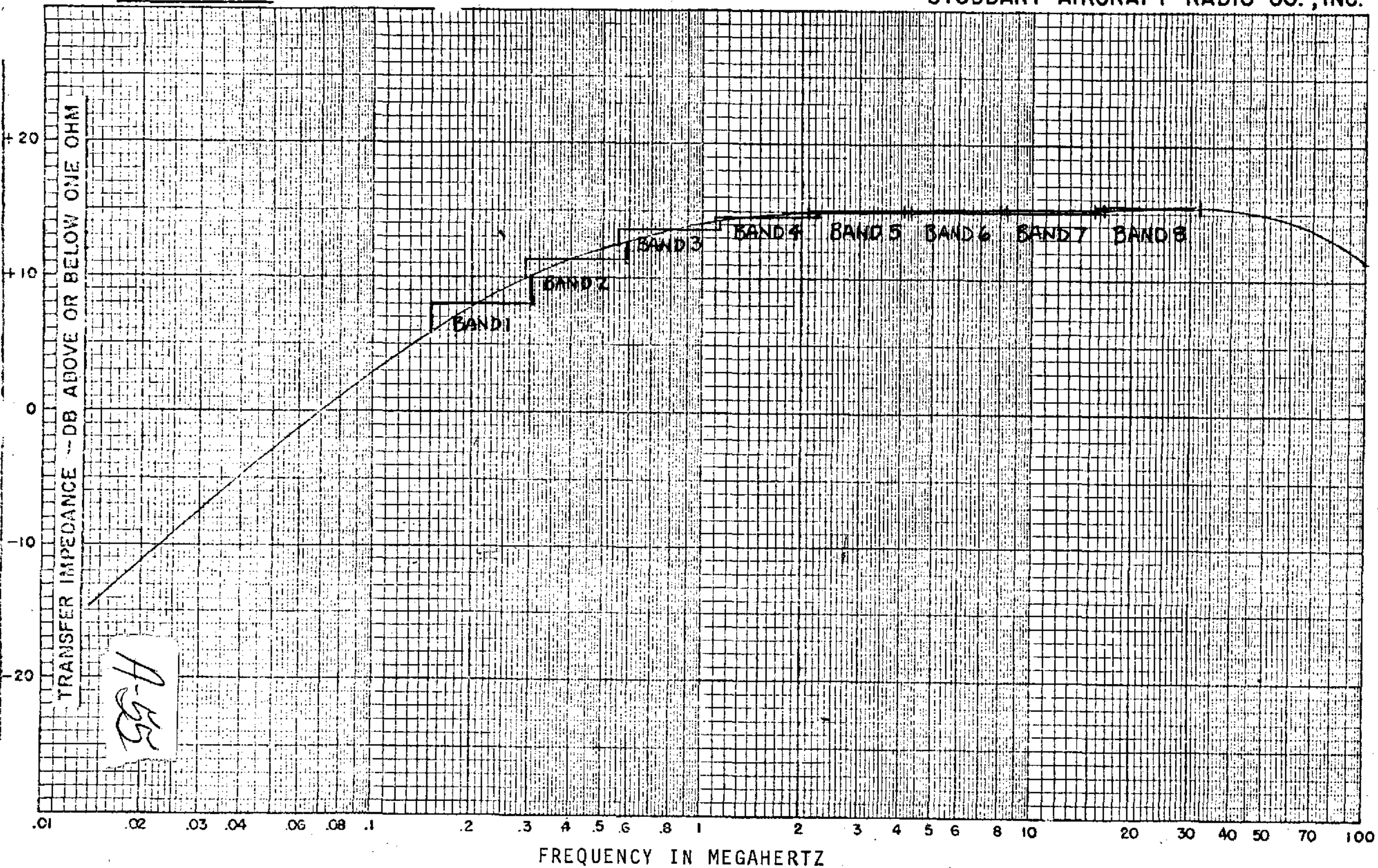


CHART A-53 CURRENT PROBE CALIBRATION

Spectrum Display A-1

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/26/74 1139

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 10 MHz/div, Log Ref Level -30 dBm

S-BAND RADAR POWER LINE

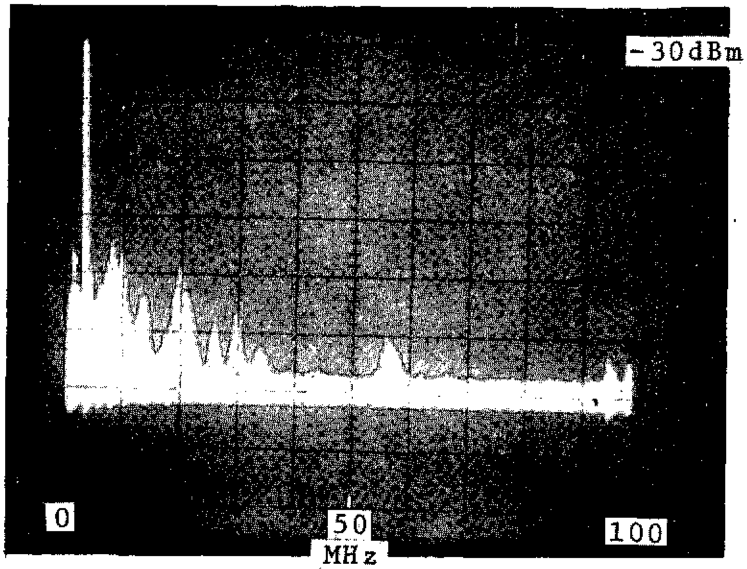
Test Point T2 LINE Filter Pos. —

STORAGE ROOM

Location ______ Harbor SAVANNAH At-Sea ____

BOTH RADARS ON

Date ______ Note ______ Observer HILL/POWELL



NOTE: This data must be adjusted for the current probe transfer impedance. See comments on first page of Appendix A. The vertical scale on the spectrum display is 10 dB per major division.

Spectrum Display A-2

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/26/74 1135

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 10 MHz/div, Log Ref Level -30 dBm

X-BAND RADAR POWER LINE

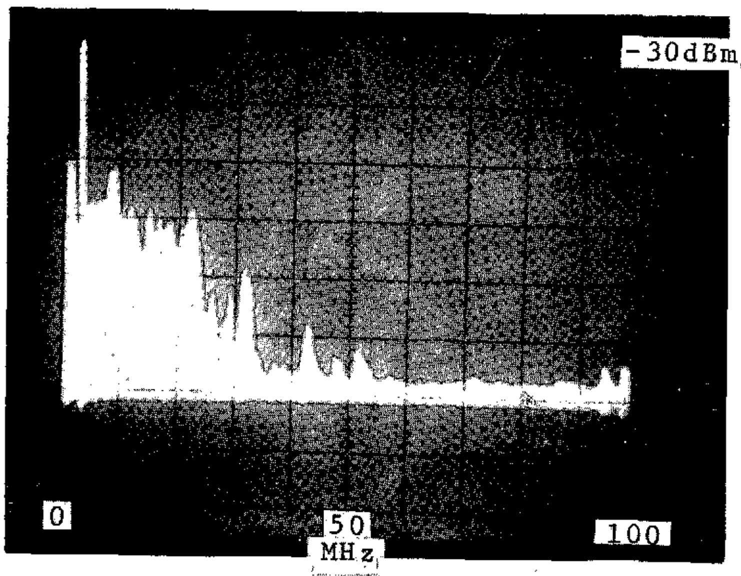
Test Point BLACK LINE Filter Pos. ______

STORAGE ROOM

Location ______ Harbor SAVANNAH At-Sea ____

BOTH RADARS ON

Date ______ Note ______ Observer HILL/POWELL



Spectrum Display A-3

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/20/74 1140

Center Freq. 70 MHz, Bandwidth 100 KHz

Scan Width 5 MHz/div, Log Ref Level -50 dBm

S-BAND RADAR POWER LINE

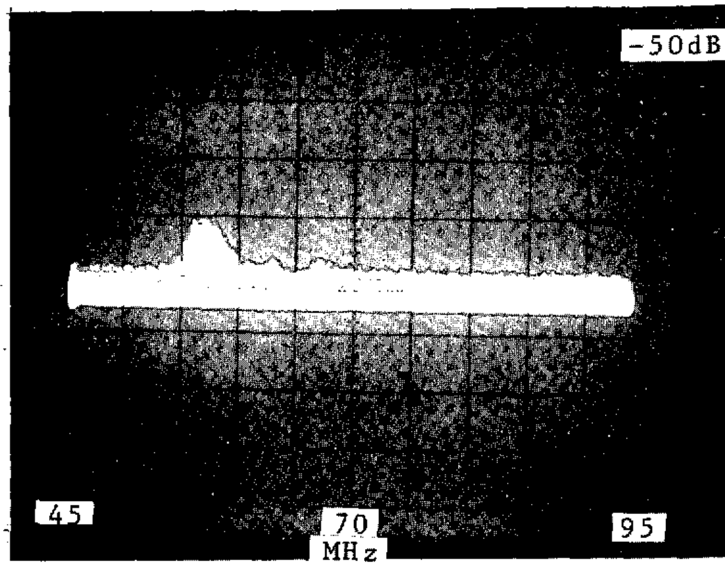
Test Point T2 LINE Filter Pos. —

STORAGE ROOM

Location ______ Harbor SAVANNAH At-Sea ______

BOTH RADARS ON

Date ______ Note ______ Observer HILL/POWELL



NOTE: This data must be adjusted for the current probe transfer impedance. See comments on first page of Appendix A. The vertical scale on the spectrum display is 10 dB per major division.

Spectrum Display A-4

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/20/74 1130

Center Freq. 70 MHz, Bandwidth 100 KHz

Scan Width 5 MHz/div, Log Ref Level -50 dBm

ON X-BAND RADAR POWER LINE

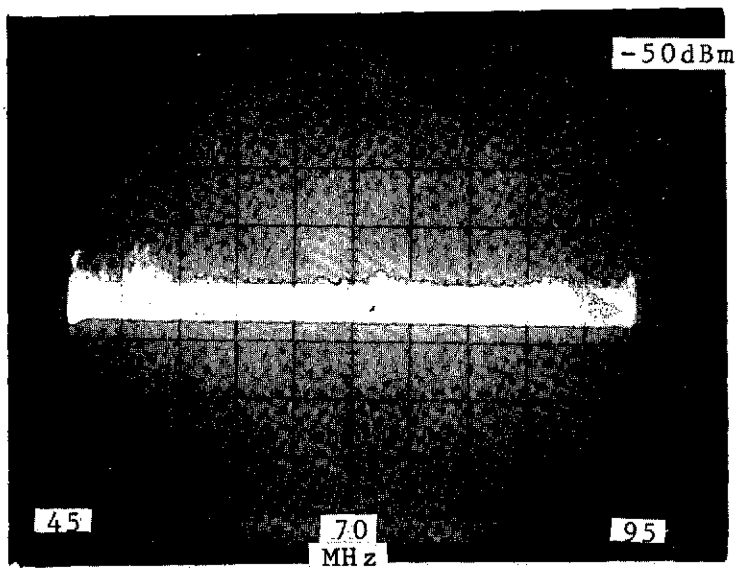
Test Point BLACK LINE Filter Pos. ______

STORAGE ROOM

Location ______ Harbor SAVANNAH At-Sea ______

BOTH RADARS ON

Date ______ Note ______ Observer HILL/POWELL



APPENDIX B, FIELD INTENSITY

Chart B-1, Adjustment Factor for Model 1010 Horn

Chart B-2, Adjustment Factor for Log Spiral Conical Antenna

Chart B-3, Radars Off, Out-of-Band, Storage Room LCS

Chart B-4, Radars off, In-Band, Storage Room Horn

Chart B-5, S-Band Radar On, Out-of-Band, Storage Room LCS

Chart B-6, S-Band Radar On, In-Band, Storage Room Horn

Chart B-7, X-Band Radar On, Out-of-Band, Storage Room LCS

Chart B-8, X-Band Radar On, In-Band, Storage Room Horn

Chart B-9, Radars On, Out-of-Band, Storage Room LCS

Chart B-10, Radars On, Out-of-Band, Mast, Aft LCS

Chart B-11, Radars On, Out-of-Band, Mast, Starboard LCS

Chart B-12, Out-of-Band, Bridge Traffic Dish

Chart B-13, Out-of-Band, Dock Area LCS

Chart B-14, Out-of-Band, Downtown Philadelphia LCS

Chart B-15, On-Band, Ben Franklin Bridge Traffic Dish

Chart B-16, Adjustment Factor for HP Spectrum Analyzer

Spectrum Display, B-1, S-Band Radar, Radar Mast

Spectrum Display, B-2, X-Band Radar, Radar Mast

Comments on the Use of These Charts and Spectrum Displays

Charts B-1 and B-2 are calibration charts giving the adjustment factors for the horn antenna or the log-spiral conical antenna with various connecting cables as used in taking the data recorded on Charts B-3 through B-11 and B-13 and B-14. Charts B-12 and B-15 were made using the 1.2 meter diameter L-band Dish Antenna and are for comparative information only because the dish antenna has only been calibrated in the maritime satellite L-band.

On each chart the ordinate scale on the left represents the instrument meter scale in dB/μv. To this must be added the proper attenuator setting of 0 dB or 20 dB as noted on the chart label. However, this is not true dB/μv because the NM-65T can only be calibrated at one frequency when the data is taken with an X-Y recorder. Because of gain variation with frequency, an adjustment must be made which is a function of frequency. This adjustment in addition to antenna factor, cable loss, and bandwidth adjustments are incorporated in Charts B-1 and B-2.

<u>Example of use of Chart B-1</u>

Chart B-1 is intended for use with Charts B-4, B-6, and B-8 which involve the model 1010 horn antenna for "in-band" measurements from 1.3 to 1.9 GHz. As an example of the use of Chart B-1 to convert values shown on the charts to broadband field intensity (from the DP trace) in dB/μv/m/MHz, read Chart B-6 at 1.6 GHz.

Meter reading	49.5 dB/μv
Attenuator reading	20.0 dB
	69.5 dB/μv
DP Antenna Factor (from Chart B-1)	8.0
Broadband field intensity	77.5 dB/μv/m/MHz

Example of use of Chart B-2

Chart B-2 is intended for use with Charts B-3, B-5, B-7, B-9, B-10, B-11, B-13, and B-14 which involve the use of the log-spiral conical antenna for measurements in the frequency range of 1.0 to 10 GHz. The upper curve is for the log-spiral conical antenna with a 15 meter length of RG-214/U cable. The lower curve is for the log-spiral conical antenna with either the 3 meter length of RG-9/U cable or the 12 meter length of Foam Wellflex cable.

As an example of the use of Chart B-2 to convert values from the FI trace shown on the charts to narrowband field intensity in dB/μv/m read Chart B-9 at 1.15 GHz.

Meter reading	8 dB/μv
Attenuator reading	0 dB
	8 dB/μv
F.I. Factor from Chart B-2	30 dB/m
	38 dB/μv/m

To convert values from the DP trace on the charts to broadband field intensity in dB/μv/m/MHz read Chart B-10 at 5.1 GHz.

Meter reading	42 dB/μv
Attenuator reading	0 dB
	42 dB/μv
DP Antenna Factor from Chart B-2	44 dB/m/MHz
	86 dB/μv/m/MHz

Data Conversion from Spectrum Display

The spectrum analyzer data as read out on the spectrum display photographs must be adjusted for antenna factor and cable loss, and normalized for bandwidth. This is accomplished with the use of Chart B-16 which incorporates these adjustments as well as the conversion from dBm to dB/μv. Simply find the adjustment factor on Chart B-16 for the frequency of interest and add this to the signal value taken from the spectrum display photograph

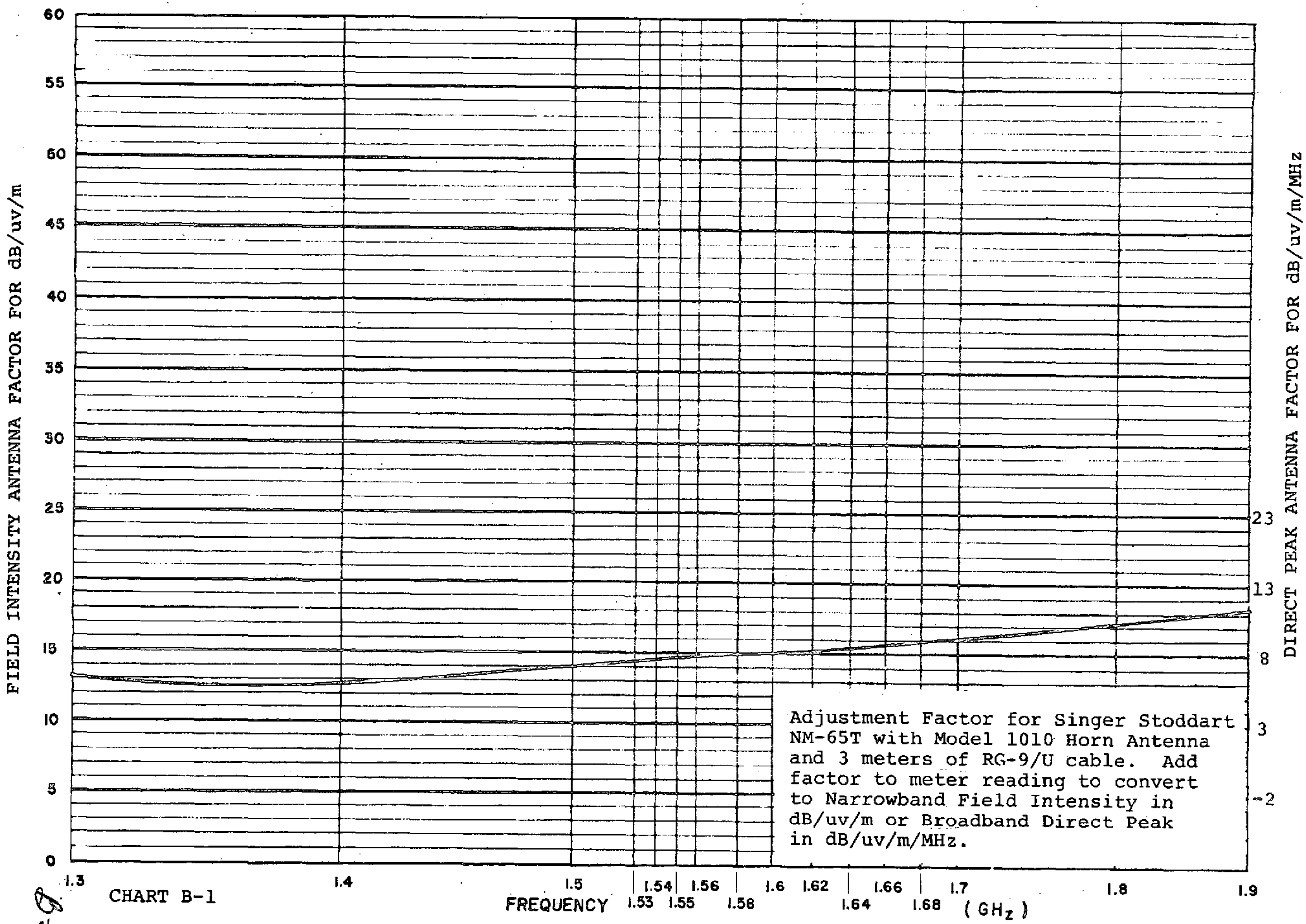
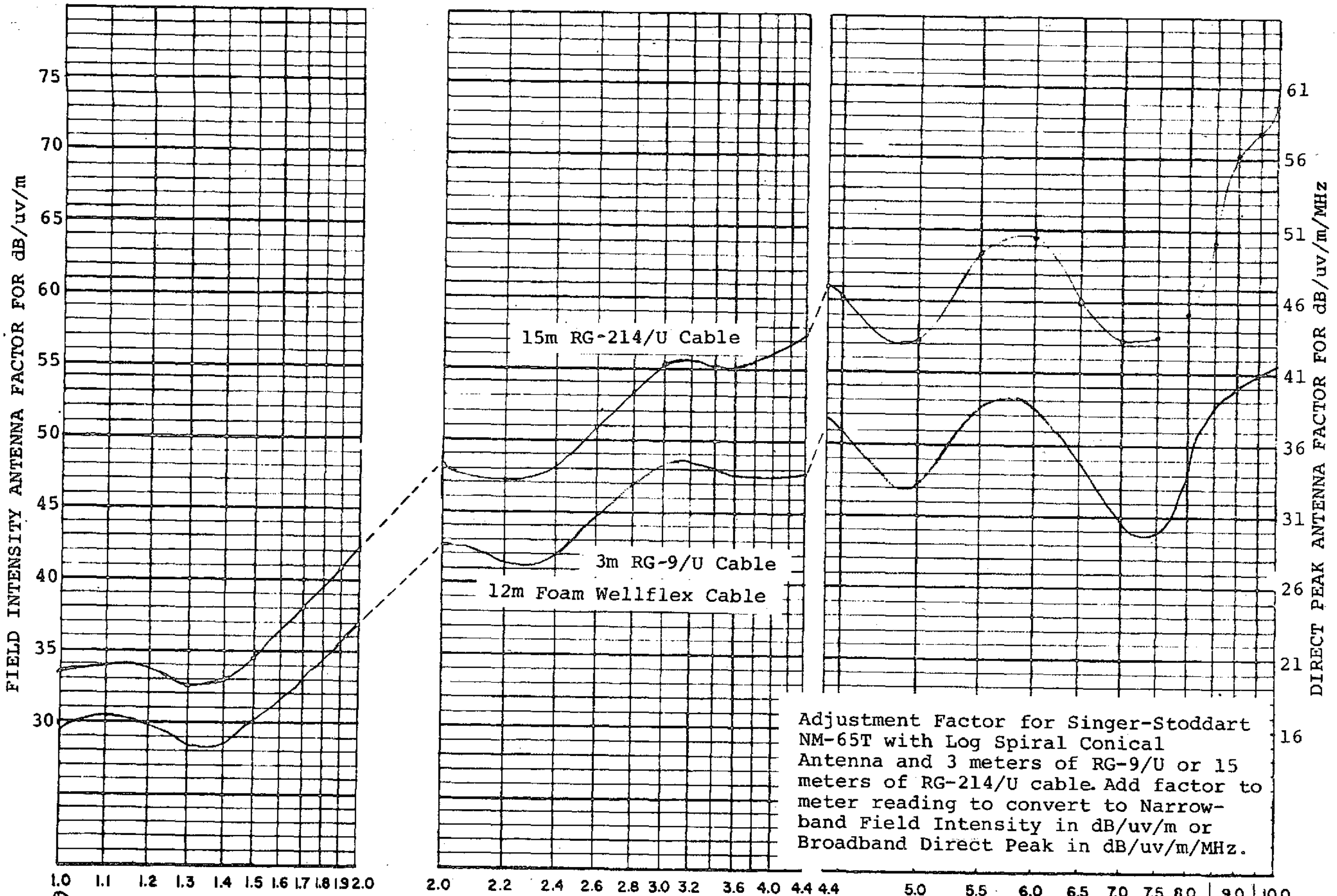

FIELD INTENSITY ANTENNA FACTOR FOR dB/uv/m
DIRECT PEAK ANTENNA FACTOR FOR dB/uv/m/MHz
60 55 60 45 40 35 30 25 20 15 10 5 0
23 13 8 3 -2
Adjustment Factor for Singer Stoddart NM-65T with Model 1010 Horn Antenna and 3 meters of RG-9/U cable. Add factor to meter reading to convert to Narrowband Field Intensity in dB/uv/m or Broadband Direct Peak in dB/uv/m/MHz.
1.3 1.4 1.5 1.53 1.54 1.55 1.56 1.58 1.6 1.62 1.64 1.66 1.68 1.7 1.8 1.9
FREQUENCY (GHz)

CHART B-1


FIELD INTENSITY ANTENNA FACTOR FOR dB/uv/m
75
70
65
60
55
50
45
40
35
30
DIRECT PEAK ANTENNA FACTOR FOR dB/uv/m/MHz
61
56
51
46
41
36
31
26
21
16
15m RG-214/U Cable
3m RG-9/U Cable
12m Foam Wellflex Cable
Adjustment Factor for Singer-Stoddart NM-65T with Log Spiral Conical Antenna and 3 meters of RG-9/U or 15 meters of RG-214/U cable. Add factor to meter reading to convert to Narrow-band Field Intensity in dB/uv/m or Broadband Direct Peak in dB/uv/m/MHz.
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)

9-9

CHART B-2

Ship Am Alliance Date 6/10/76 1220

Location Storage Room Harbor X Pt. Elizabeth At-Sea

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 20 dB Function DP Observer — 3m Cable

Test Point — Radars off (stand by) Filter Pos. —

Note Log-Spiral Conical Ant. 1 meter in front of S-Band Cabinet

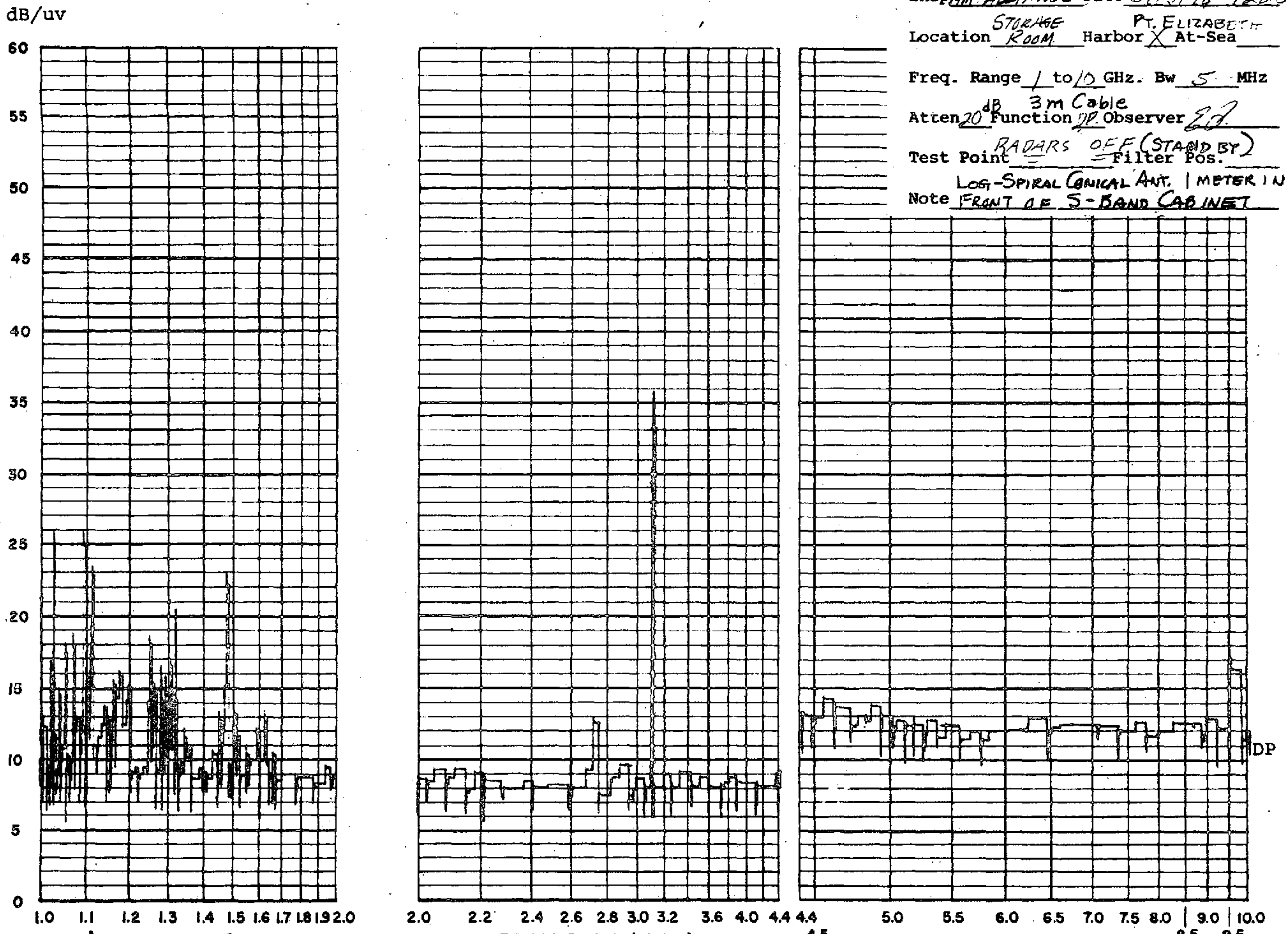


CHART B-3

B-7

Shipboard L-Band Terminal EMI Survey

Ship Am. Alliance Date [illegible]

Location [illegible] Harbor X P. Elizabeth At-Sea

Freq. Range [illegible] to [illegible] GHz. Bw 5 MHz

Atten [illegible] dB 3m Cable Function [illegible] Observer [illegible]

Test Point [illegible] (STANDBY) Filter Pos.

Note L-Band Horn Antenna 1 Meter in front of S-Band Cabinet

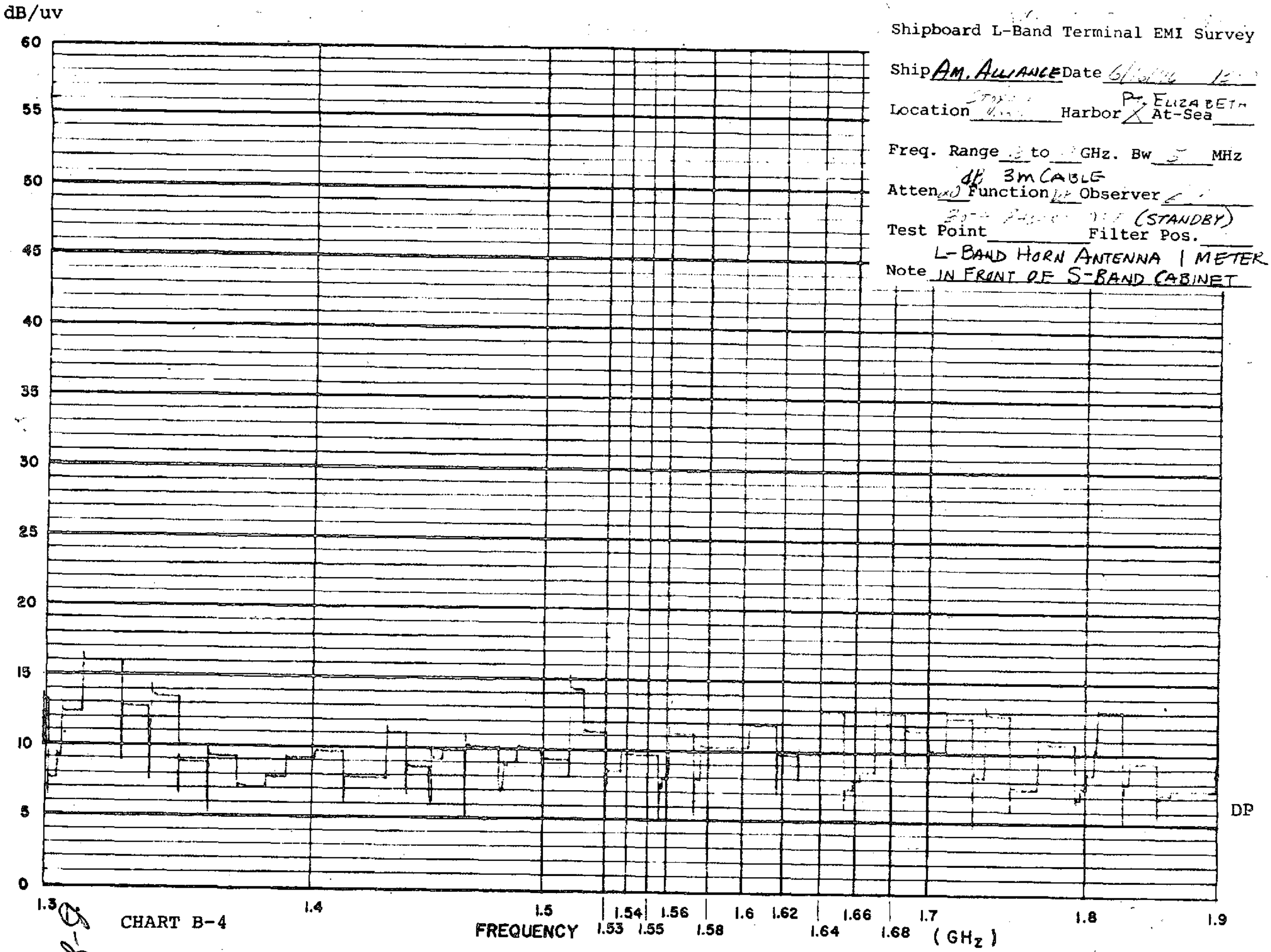


CHART B-4

Ship AM. ALLIANCE Date

Location STORAGE ROOM Harbor PT. ELIZABETH At-Sea

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 20 dB 3m CABLE Function DP Observer

Test Point S-BAND PANEL Filter Pos.

Note LOG-SPIRAL CONICAL ANTENNA 1 METER IN FRONT OF S-BAND CABINET

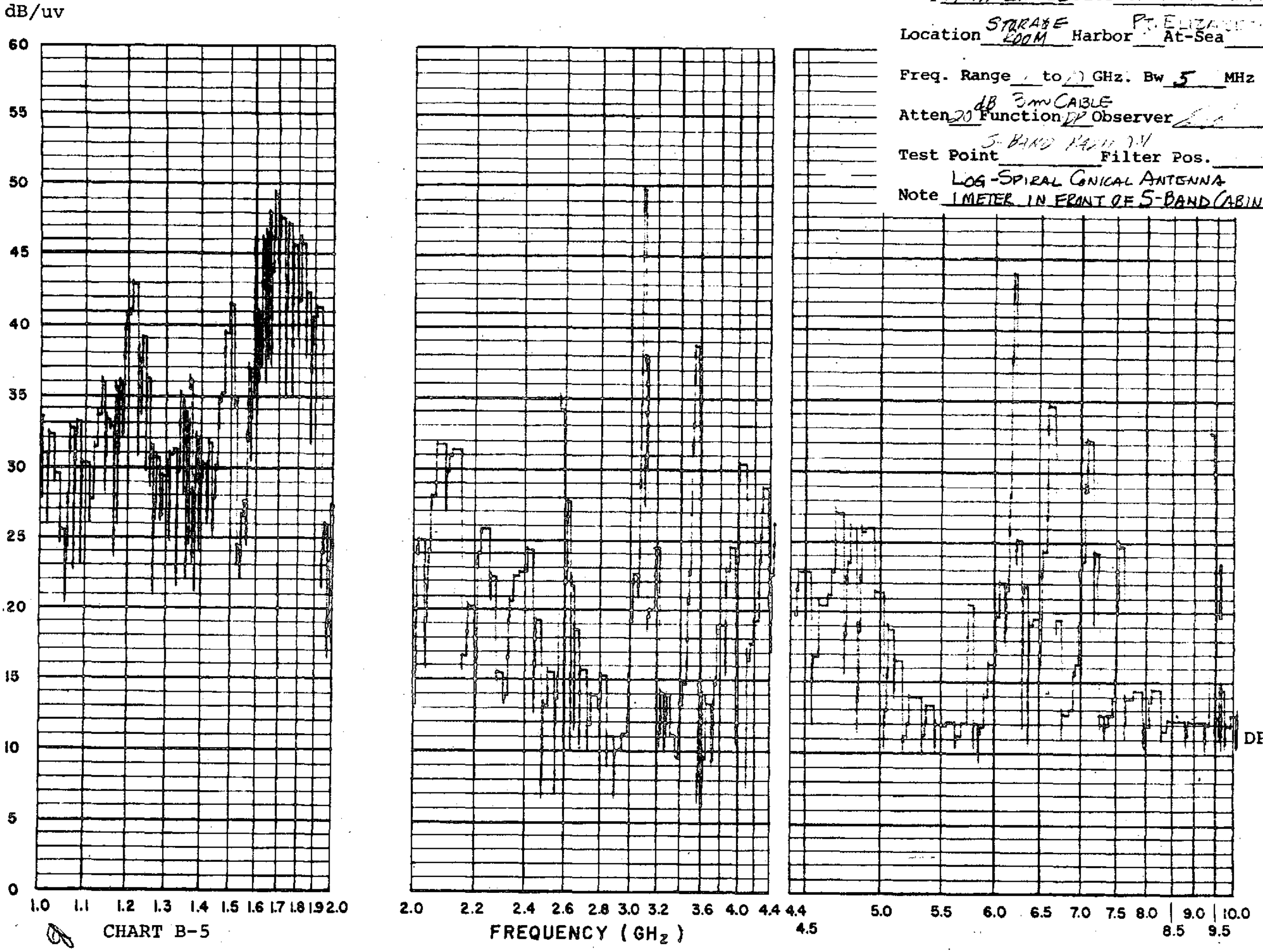


CHART B-5

B-9

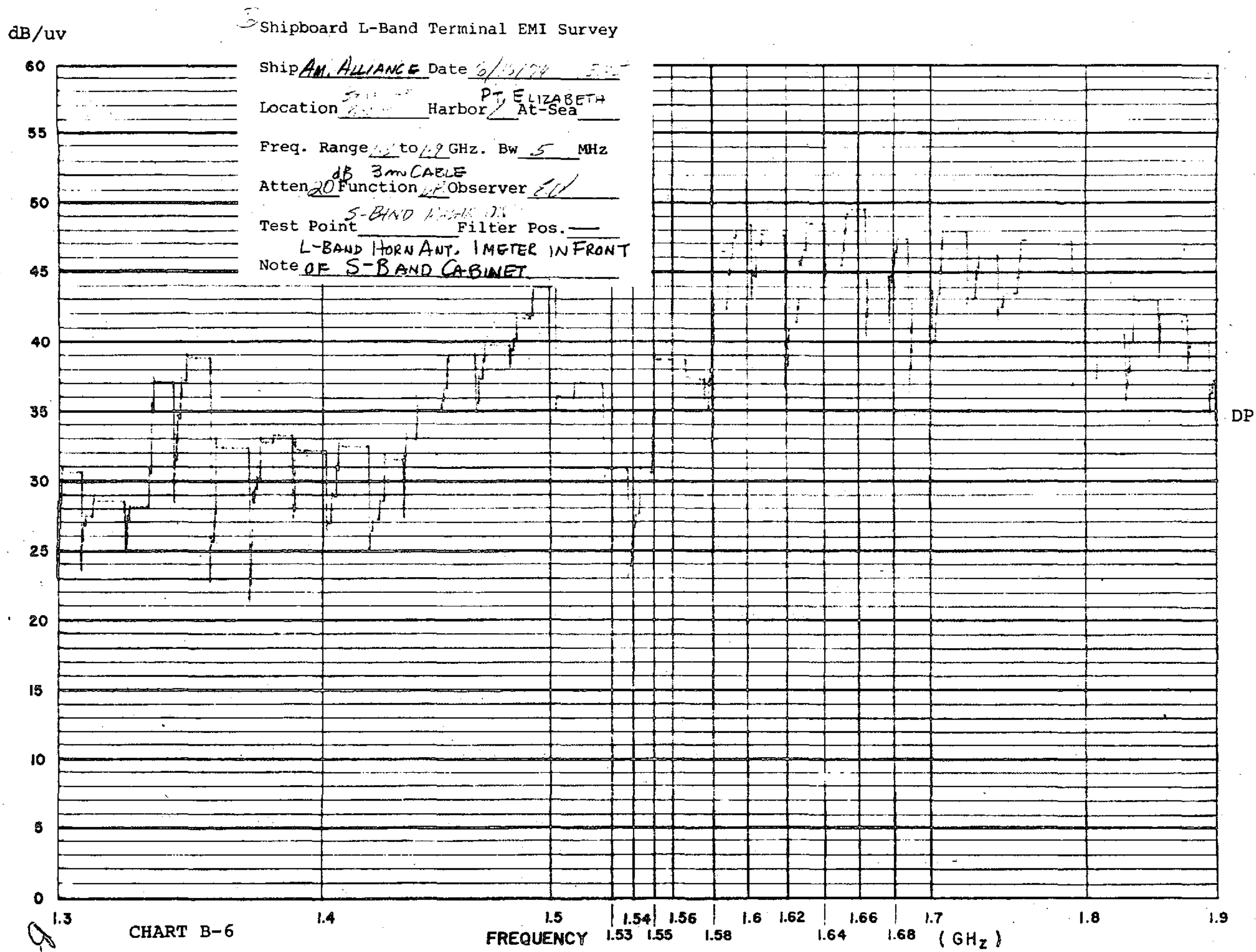
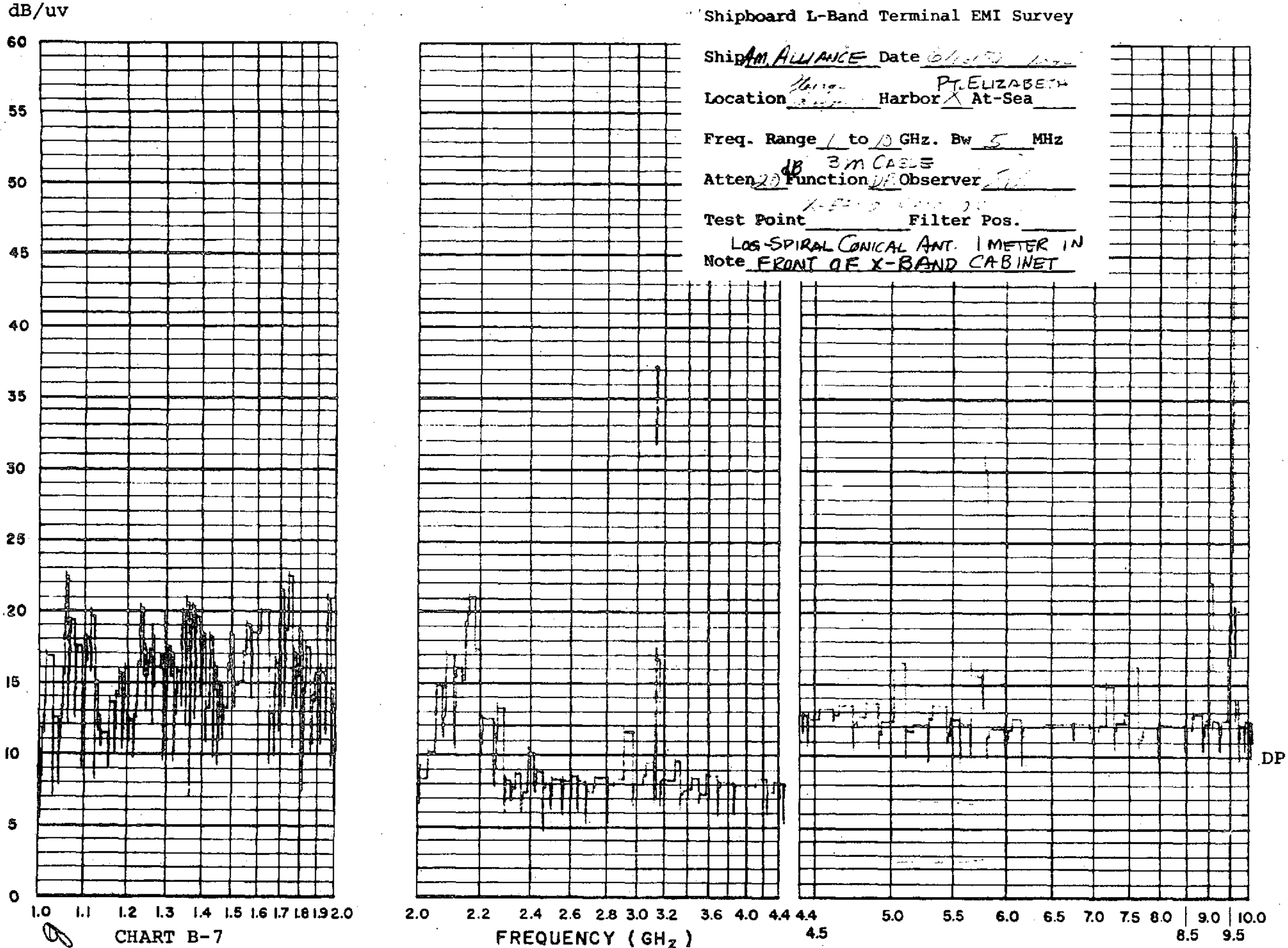

Shipboard L-Band Terminal EMI Survey
Ship AM. ALLIANCE Date
Location
Harbor PT. ELIZABETH At-Sea
Freq. Range to GHz. Bw 5 MHz
Atten 20 dB Function Observer
3m CABLE
Test Point S-BAND
Filter Pos. —
Note L-BAND HORN ANT. 1METER IN FRONT OF S-BAND CABINET
dB/uv
60
55
50
45
40
35
30
25
20
15
10
5
0
DP
1.3
1.4
1.5
1.53
1.54
1.55
1.56
1.58
1.6
1.62
1.64
1.66
1.68
1.7
1.8
1.9
FREQUENCY (GHz)

CHART B-6

B-10



dB/uv
60
55
50
45
40
35
30
25
20
15
10
5
0
Shipboard L-Band Terminal EMI Survey
Ship AM. ALLIANCE Date
Location Harbor X At-Sea
PT. ELIZABETH
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 20 dB Function 3m CABLE Observer
Test Point Filter Pos.
Note LOG-SPIRAL CONICAL ANT. 1 METER IN FRONT OF X-BAND CABINET
DP
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GH_z)

CHART B-7

11-8

Shipboard L-Band Terminal EMI Survey

Ship AM. ALLIANCE Date

Location Harbor PT. ELIZABETH At-Sea

Freq. Range to GHz. Bw MHz

Atten 0 dB Function Observer

3m CABLE

Test Point X-BAND Filter Pos.

Note L-BAND HORN ANT. 1 METER IN FRONT OF X-BAND CABINET

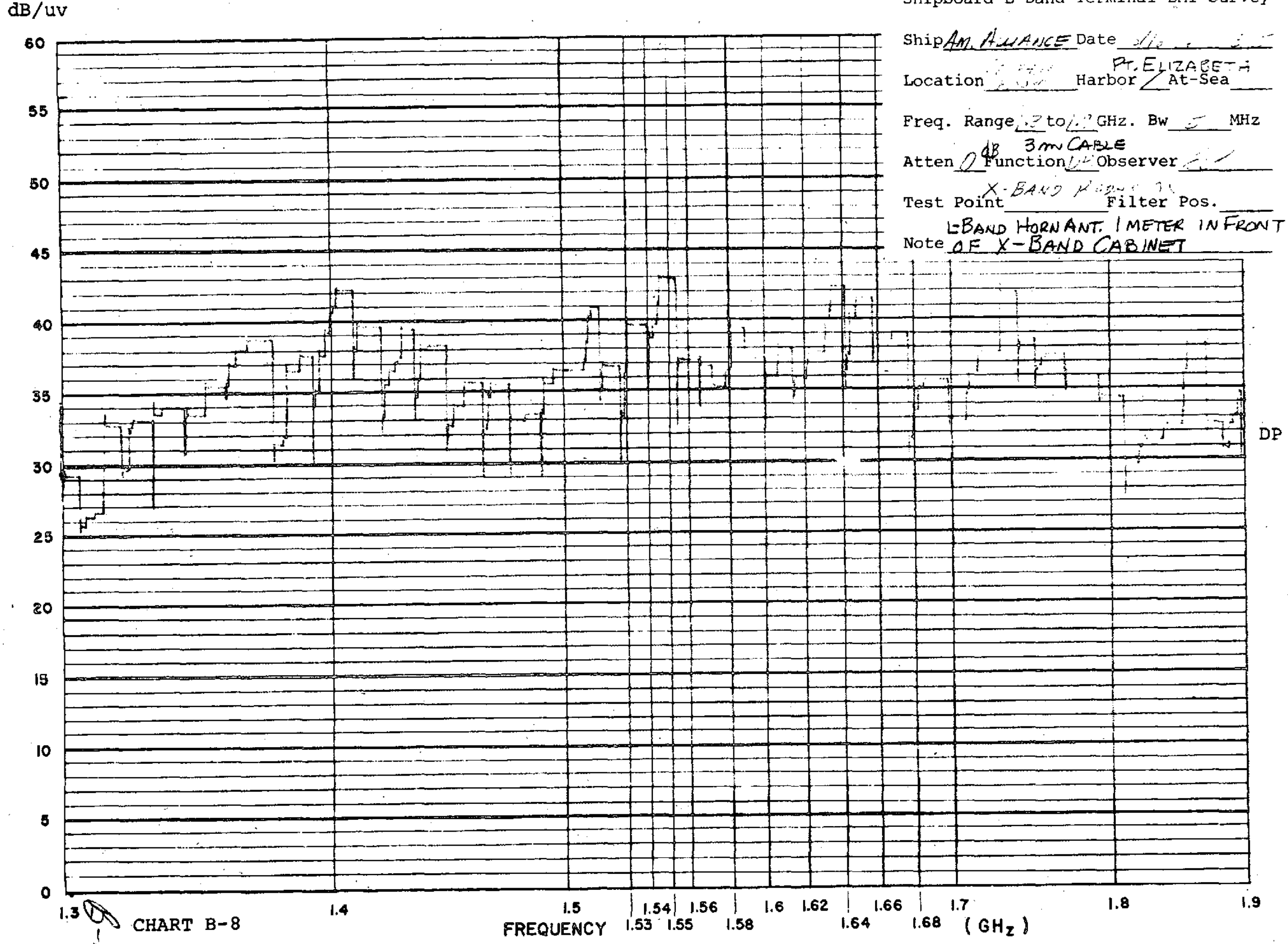


CHART B-8

B-12

Shipboard L-Band Terminal EMI Survey

Ship ________ Date ________

Location ________ Harbor X At-Sea ____ SAVANNAH

Freq. Range ___ to ___ GHz. Bw 5 MHz

Atten 0 dB Function ____ Observer J.H/E.P.

Test Point ________ SPIRAL ANT. Filter Pos. —

Note 12 m LowLoss CABLE

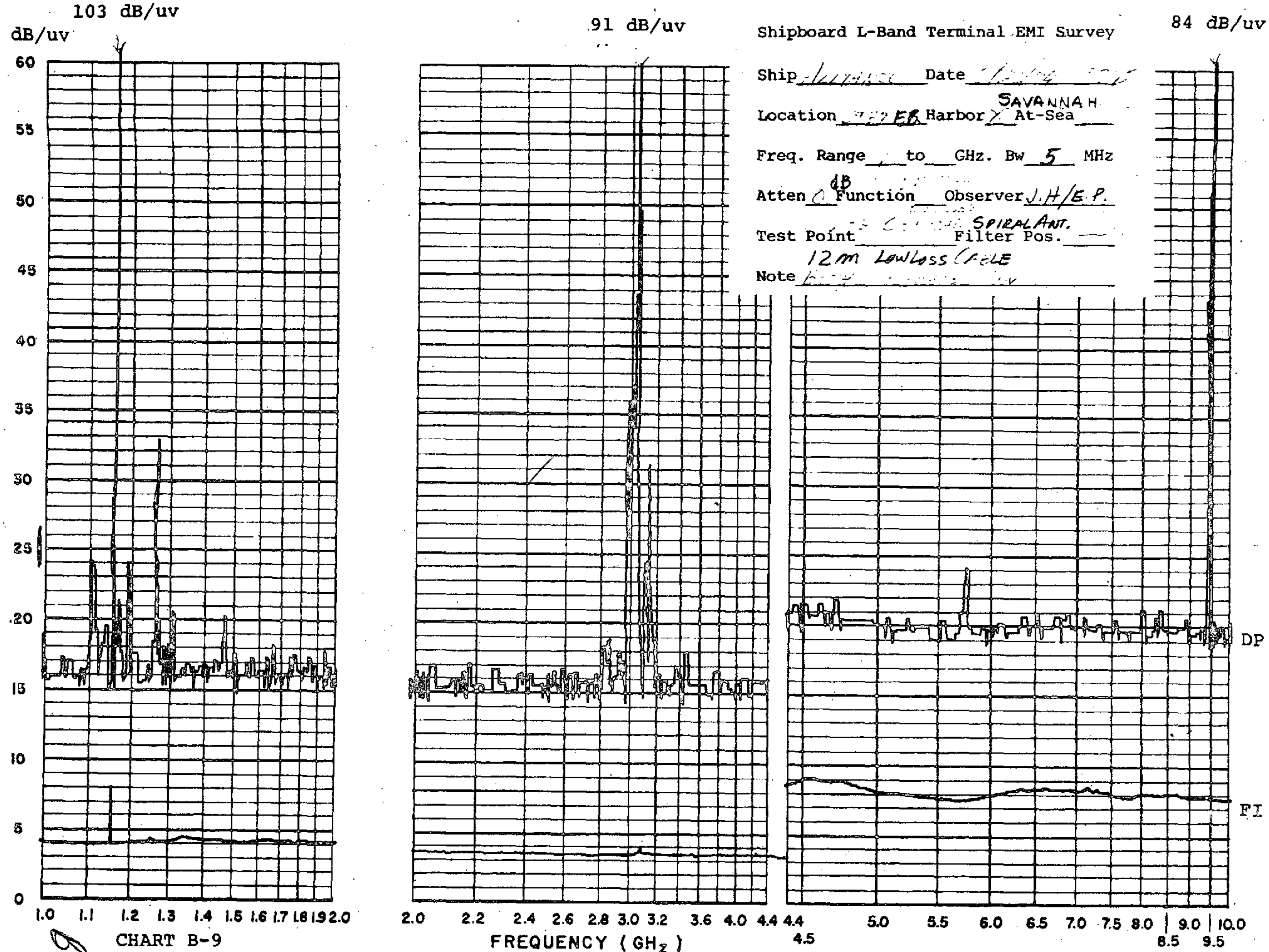


CHART B-9

B-13

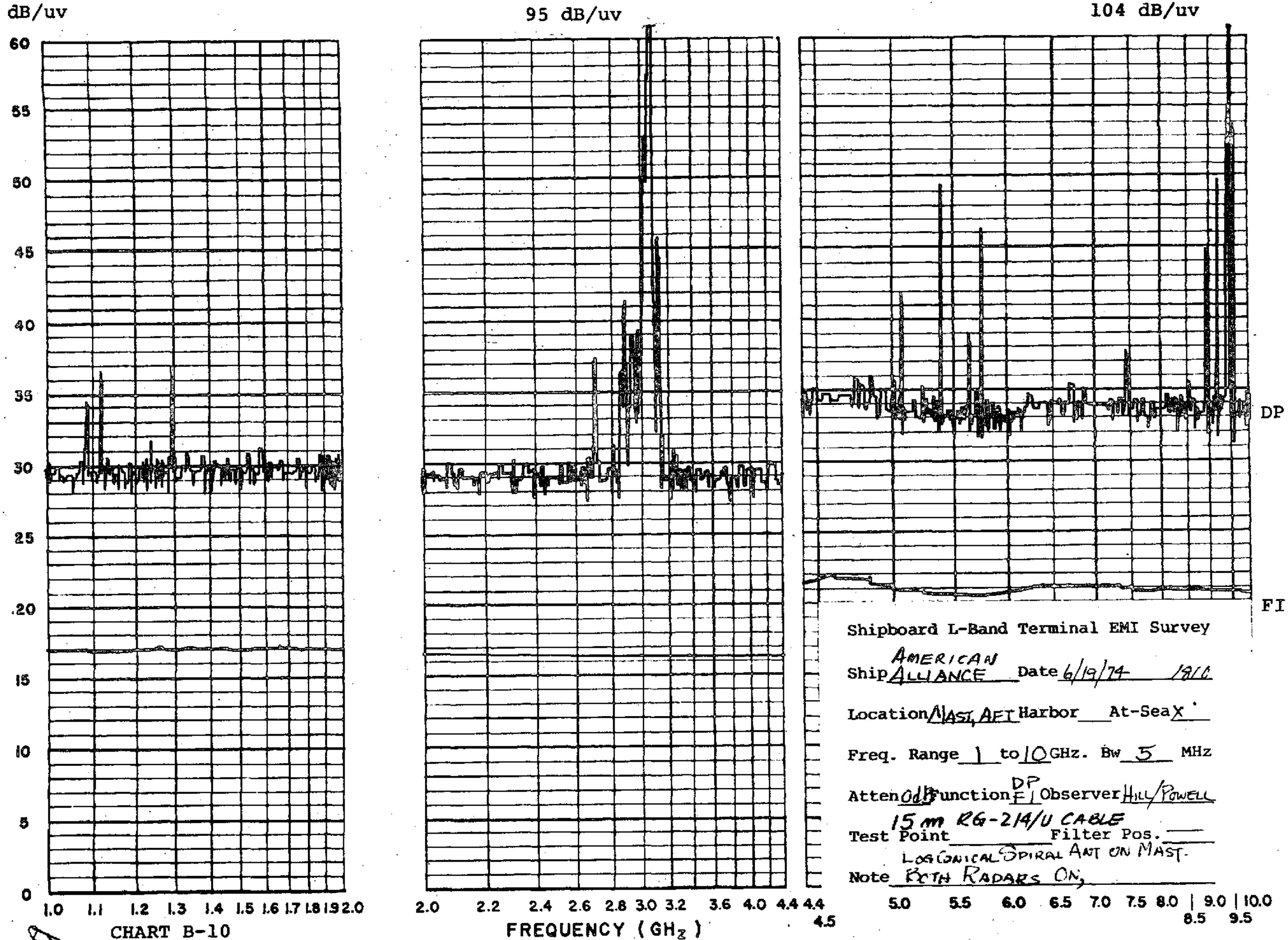
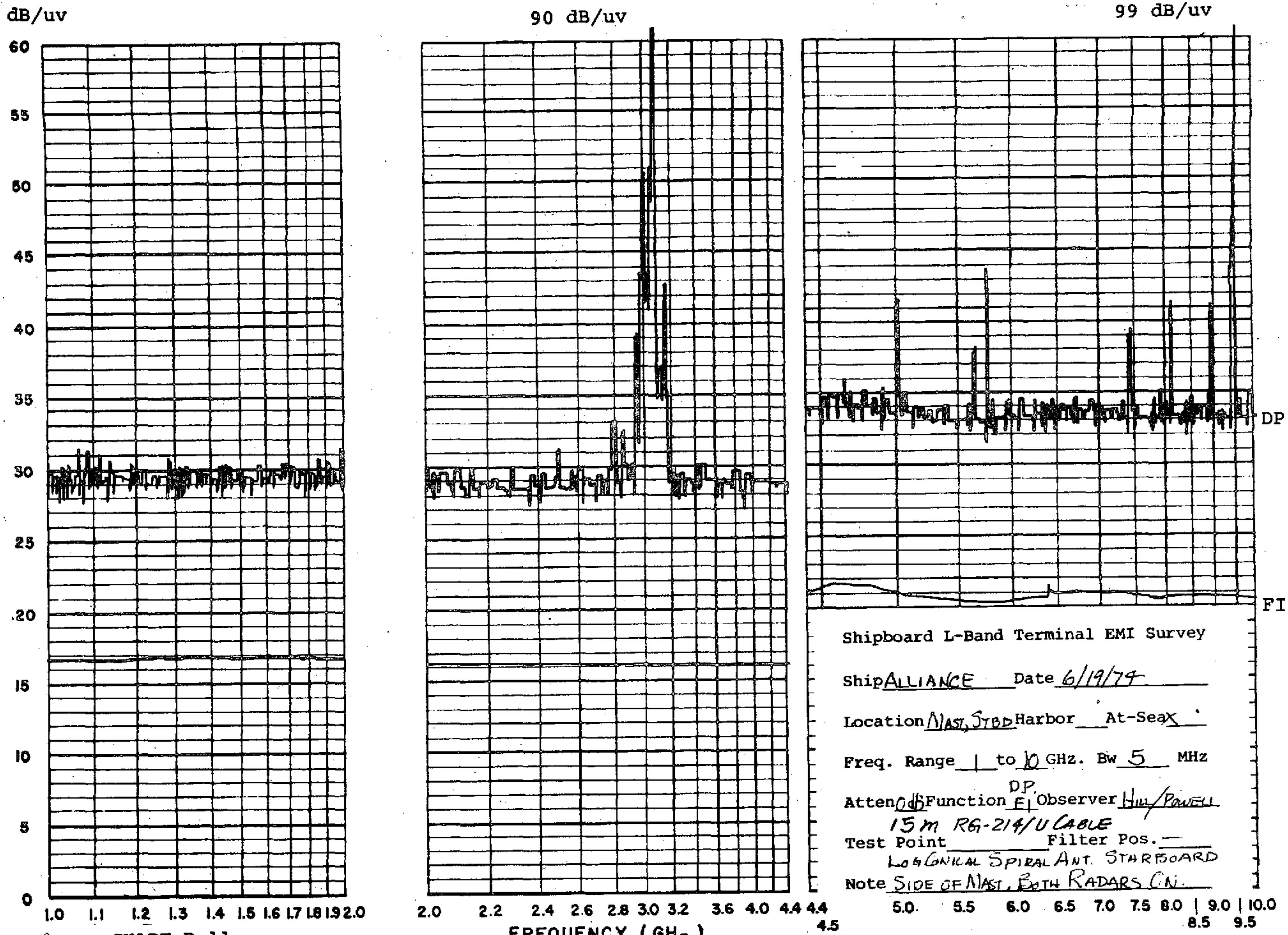


CHART B-10

4-18



dB/uv
90 dB/uv
99 dB/uv
60
55
50
45
40
35
30
25
20
15
10
5
0
DP
FI
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/19/74
Location MAST, STBD Harbor ___ At-Sea X
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 0 dB Function DP FI Observer HILL/POWELL
Test Point 15 m RG-214/U CABLE Filter Pos. —
Note LOG CONICAL SPIRAL ANT. STARBOARD SIDE OF MAST, BOTH RADARS ON.

CHART B-11

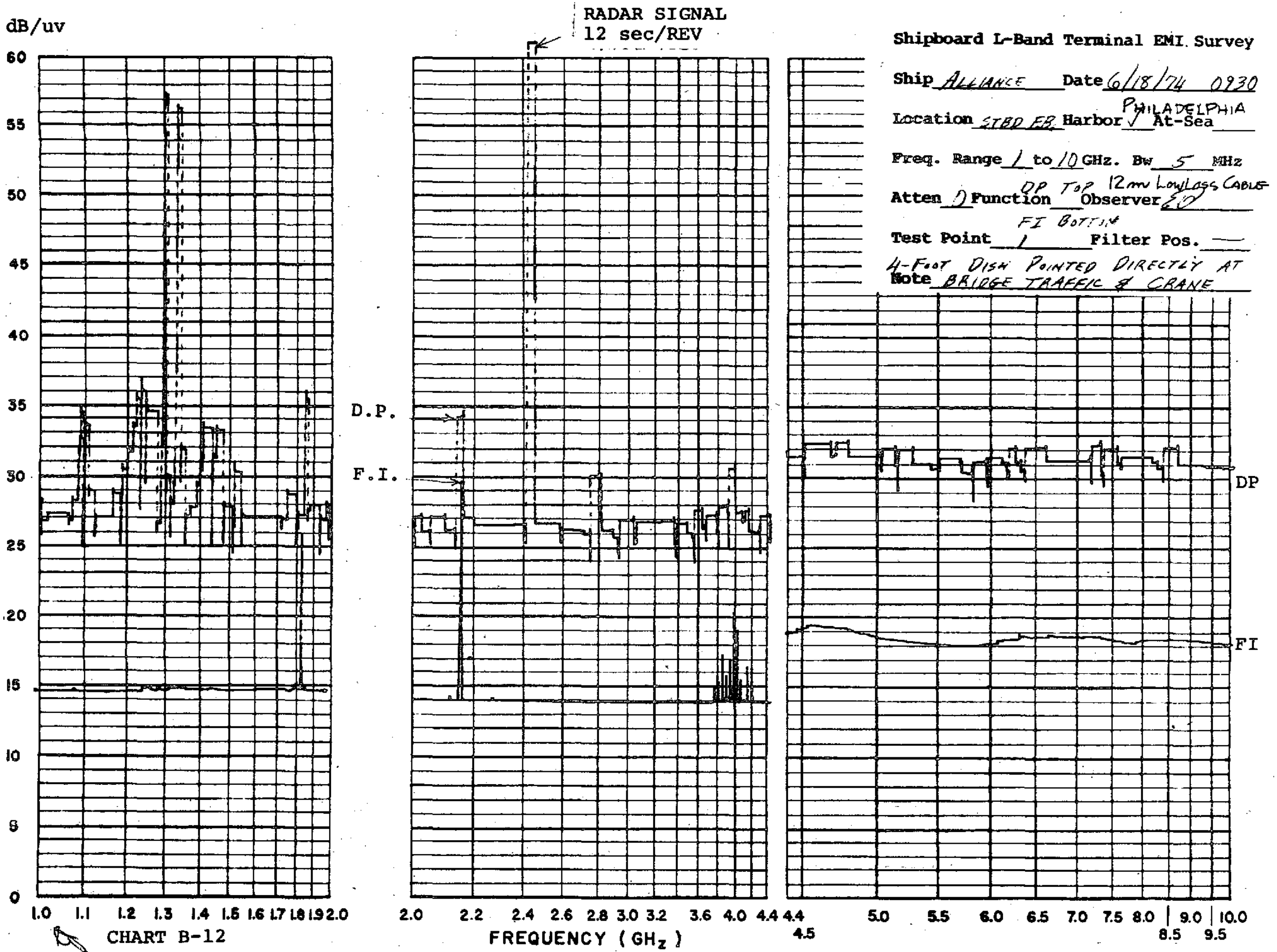

RADAR SIGNAL
12 sec/REV
dB/uv
60
55
50
45
40
35
30
25
20
15
10
5
0
D.P.
F.I.
DP
FI
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/18/74 0930
Location STBD FB Harbor ✓ PHILADELPHIA At-Sea
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 0 Function DP TOP FI BOTTOM Observer ED 12 mm LowLoss Cable
Test Point 1 Filter Pos. —
Note 4-FOOT DISH POINTED DIRECTLY AT BRIDGE TRAFFIC & CRANE
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)

CHART B-12

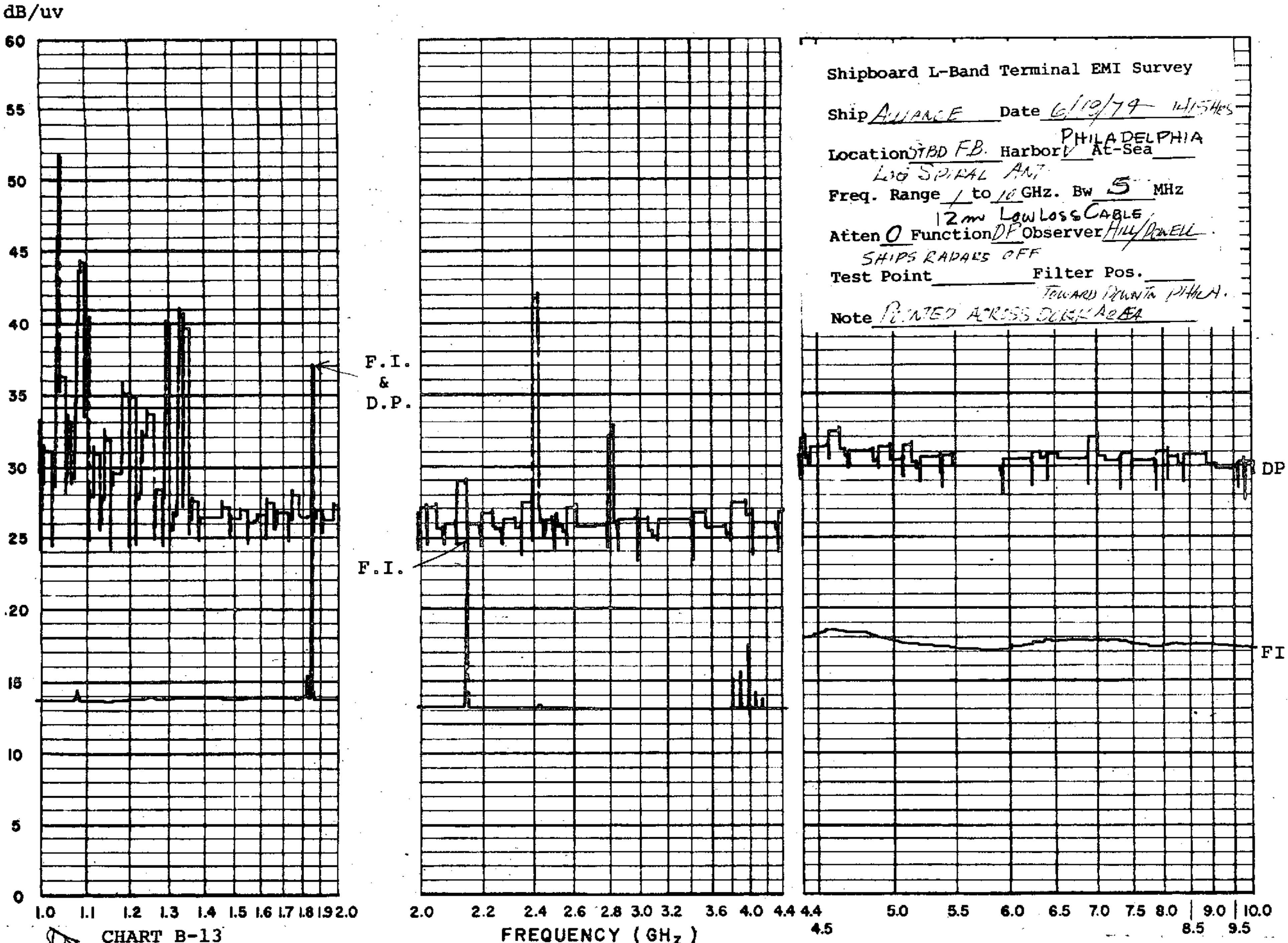

dB/uv
60
55
50
45
40
35
30
25
20
15
10
5
0
F.I. & D.P.
F.I.
DP
FI
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/19/79 1415HRS
Location STBD F.B. Harbor ✓ PHILADELPHIA At-Sea
LOG SPIRAL ANT
Freq. Range 1 to 10 GHz. Bw 5 MHz
12m LOW LOSS CABLE
Atten 0 Function DF Observer HILL/POWELL
SHIPS RADARS OFF
Test Point Filter Pos.
TOWARD DOWNTN PHILA.
Note POINTED ACROSS DOCK AREA

CHART B-13

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/12/74 1430 Hrs

Location DTBD P.B. DELAWARE RIVER Harbor At-Sea

LOG CONICAL SPIRAL ANT.

Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz

12m Low Loss CABLE DP/ 15m Low Loss CABLE

Atten 0 Function DP/FI Observer HILL/POWELL

Test Point ______ Filter Pos. ______

Note JUST OFF DOCK IN RIVER LOOKING AT DOWNTOWN PHILA.

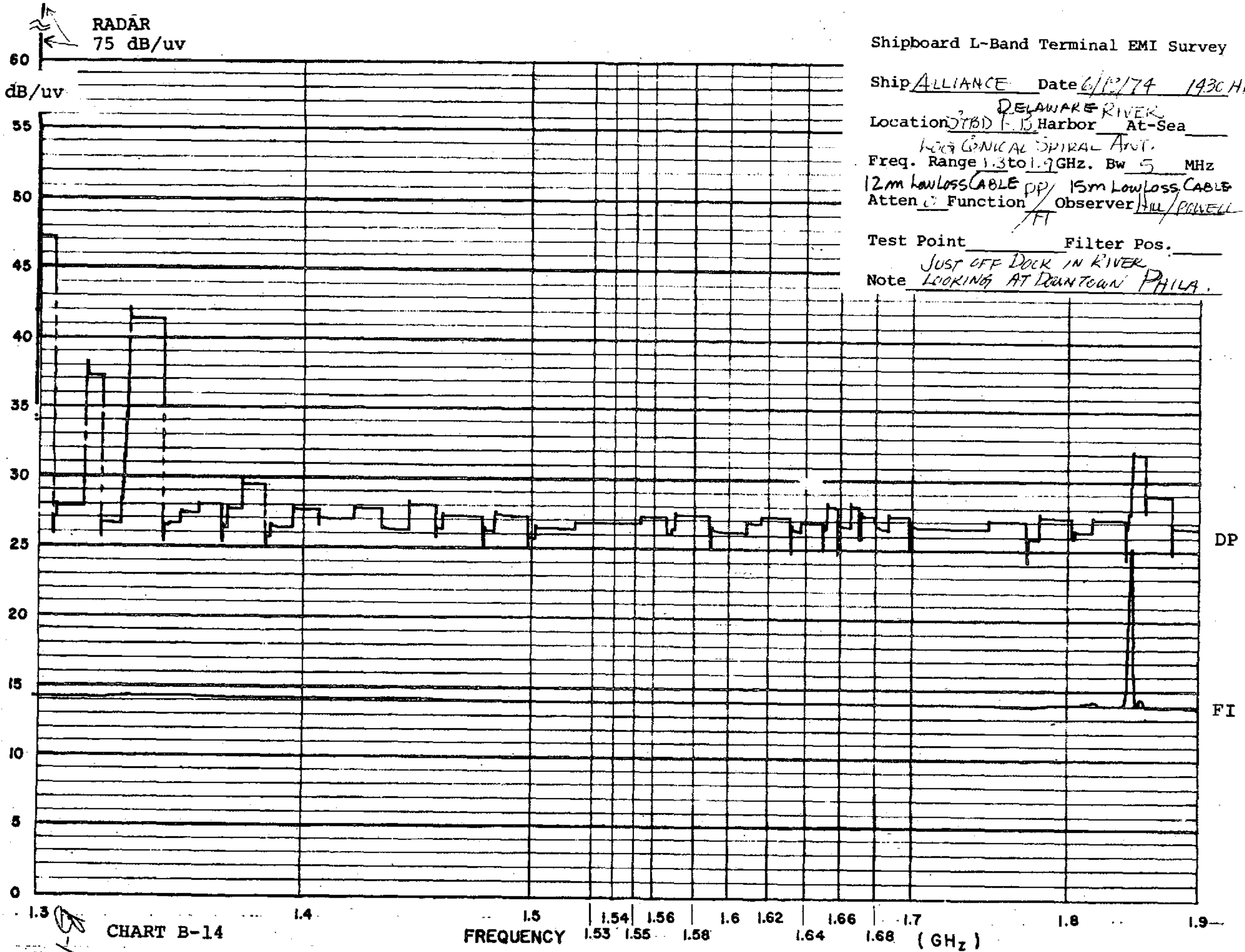
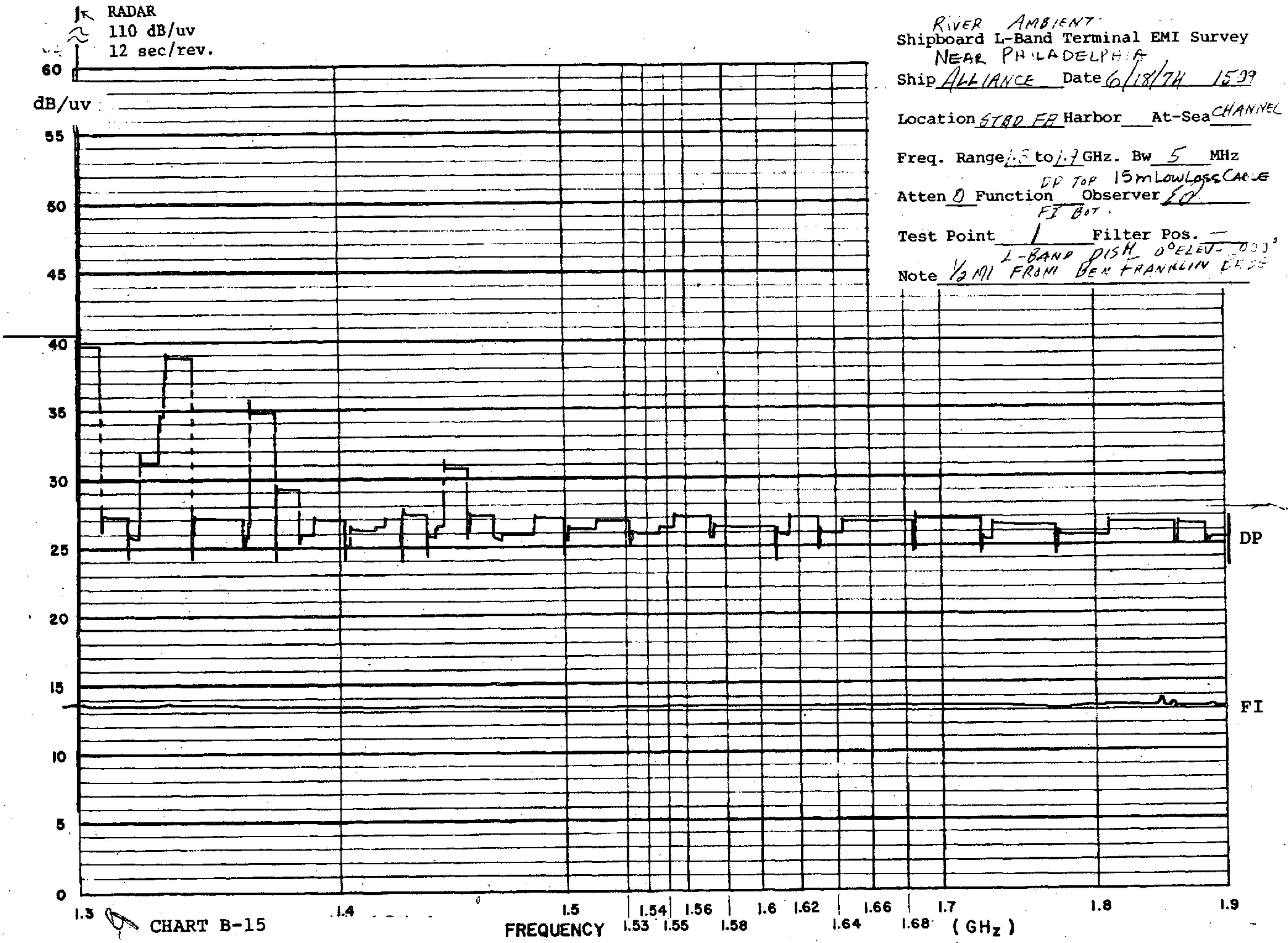


CHART B-14

B-18



RADAR
110 dB/uv
12 sec/rev.
RIVER AMBIENT
Shipboard L-Band Terminal EMI Survey
NEAR PHILADELPHIA
Ship ALLIANCE Date 6/18/74 1509
Location STBD FB Harbor At-Sea CHANNEL
Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz
Atten 0 Function DP TOP FI BOT. Observer EO 15m Low Loss Cable
Test Point 1 Filter Pos. —
Note 1/2 MI FROM BEN FRANKLIN BRIDGE L-BAND DISH 0° ELEV 030°
dB/uv
60
55
50
45
40
35
30
25
20
15
10
5
0
DP
FI
1.3
1.4
1.5
1.53
1.54
1.55
1.56
1.58
1.6
1.62
1.64
1.66
1.68
1.7
1.8
1.9
FREQUENCY (GHz)

CHART B-15

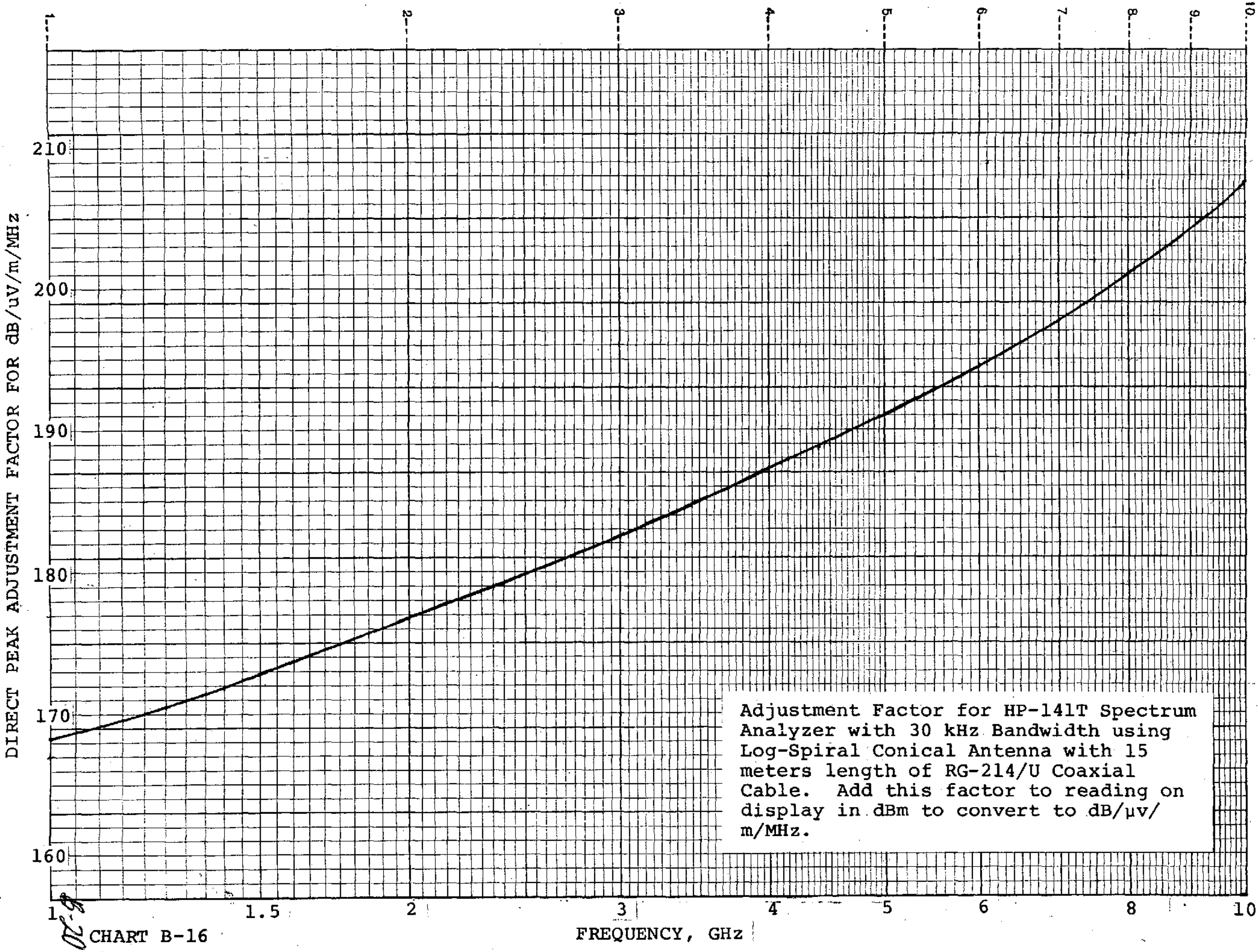

DIRECT PEAK ADJUSTMENT FACTOR FOR dB/uV/m/MHz
210
200
190
180
170
160
1
1.5
2
3
4
5
6
8
10
FREQUENCY, GHz
Adjustment Factor for HP-141T Spectrum Analyzer with 30 kHz Bandwidth using Log-Spiral Conical Antenna with 15 meters length of RG-214/U Coaxial Cable. Add this factor to reading on display in dBm to convert to dB/μv/m/MHz.

CHART B-16

Spectrum Display B-1

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1920

Center Freq. 3050 MHz, Bandwidth 30 KHz

Scan Width 50 MHz/div, Log Ref Level -40 dBm

15m RG-214/U CABLE

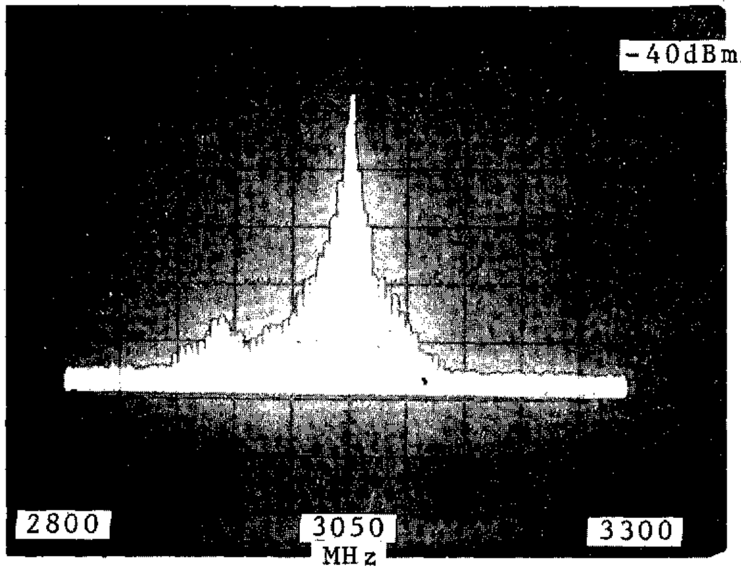
Test Point LOG CONICAL Filter Pos. ——

ANT ON STARBOARD SIDE OF RADAR MAST

Location ______ Harbor ______ At-Sea X

S-BAND RADAR ON SCAN TIME

Date ______ Note 1SEC/DIV Observer HILL/POWELL



The spectrum display photograph data must be adjusted for antenna factor, cable loss, and bandwidth using Chart B-16. For explanation see first page of Appendix B. The vertical scale on the spectrum display is 10 dB per major division.

Spectrum Display B-2

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1908

Center Freq. 9330 MHz, Bandwidth 30 KHz

Scan Width 10 MHz/div, Log Ref Level -40 dBm

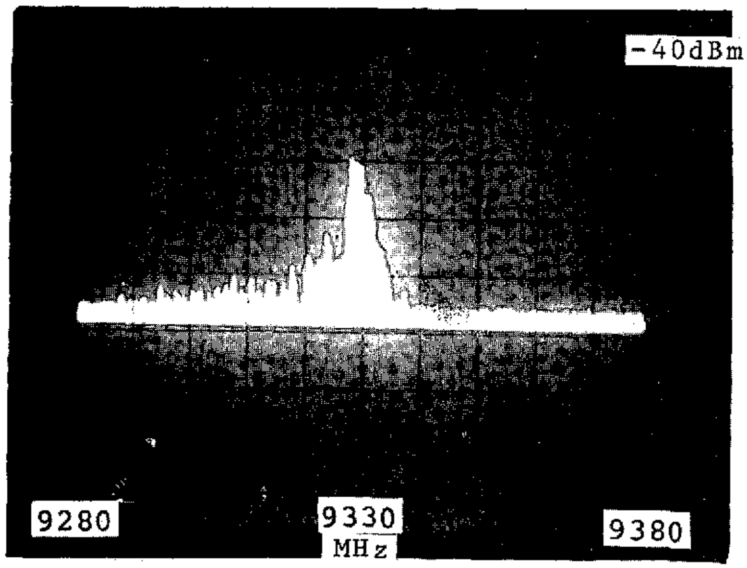
Test Point LOG CONICAL SPIRAL ANT Filter Pos. ______

WITH 50' OF RG-214U, LOOKING TOWARD PORTSIDE

Location MAST, STBD Harbor ______ At-Sea X

X BAND RADAR ON SCAN TIME

Date ______ Note 2SEC/DIV Observer HILL/POWELL



APPENDIX C, FILTER EVALUATION

Spectrum Display C-1, T.P.1, S-Band Radar On

Spectrum Display C-2, T.P.1, X-Band Radar On

Spectrum Display C-3, T.P.2, S-Band Radar On

Spectrum Display C-4, T.P.1, Radars Off, Shore Signal

Spectrum Display C-5, T.P.1, S-Band Radar On

Spectrum Display C-6, T.P.1, Radars On

Spectrum Display C-7, T.P.1, S-Band Radar On

Spectrum Display C-8, T.P.1, S-Band Radar On

Spectrum Display C-9, T.P.1, S-Band Radar On, 0.5-2.5 GHz

Spectrum Display C-10, T.P.2, S-Band Radar On, 0.5-2.5 GHz

Spectrum Display C-11, T.P.3, S-Band Radar On, 0.5-2.5 GHz

Spectrum Display C-12, T.P.1, S-Band Radar On, 2.07-6.15 GHz

Spectrum Display C-13, T.P.2, S-Band Radar On, 2.07-6.15 GHz

Spectrum Display C-14, T.P.3, S-Band Radar On, 2.07-6.15 GHz

Spectrum Display C-15, T.P.1, S-Band Radar On, 6.17-10.25 GHz

Spectrum Display C-16, T.P.2, S-Band Radar On, 6.17-10.25 GHz

Spectrum Display C-17, T.P.3, S-Band Radar On, 6.17-10.25 GHz

Spectrum Display C-18, T.P.4, Radars Off

Spectrum Display C-19, T.P.4, Radars Off

Spectrum Display C-20, Spectrum Analyzer Spurious Display

Spectrum Display C-21, T.P.4, Radars Off, Filter In

Spectrum Display C-22, T.P.4, Radars Off, Filter Out

Spectrum Display C-23, T.P.4, Radars On, Filter Out

Spectrum Display C-24, T.P.4, Radars On, Filter In

Comments on the Use of the Charts and Spectrum Displays

The Charts C-1 through C-22, made with the Stoddart NM-65 Radio Interference Analyzer, require interpretation with an adjustment factor which is supplied in Chart C-23. This adjustment factor compensates for the variation of gain with frequency when the NM-65 is calibrated at one frequency, as it must be for use with the X-Y recorder.

For example, refer to Chart C-5 at the frequency 3.1 GHz, the broadband magnitude on the chart scale is 53 dB for the DP trace.

From Chart C-5	53 dB
Attenuator setting	20 dB
	73 dB
Adjustment Factor from Chart C-23	-4 dB/μv/MHz
Adjusted value	69 dB/μv/MHz

Thus 69 dB/μv/MHz is the adjusted level at 3.1 GHz at Test Point 1 with the S-band radar on. The spectrum display photographs require no adjustment to obtain the peak signal level in dBm. Each major division on the vertical scale on the spectrum display is 10 dB. To convert to dB/μv/MHz requires an adjustment for bandwidth. This bandwidth factor is equal to 20 log $\frac{1\ \text{MHz}}{\text{BW}}$. For example by reference to Spectrum Display C-4, where the maximum signal level is -58 dBm at approximately 1296.5 MHz and the bandwidth is 100 kHz, the signal level in dB/μv/MHz would be found as follows:

Signal level from Spectrum Display C-4	- 58 dBm
conversion to μv	+107 dB
	49 dB/μv
bandwidth adjustment A_{BW}	+ 20 dB/MHz
adjusted value of broadband signal	69 dB/μv/MHz

where $A_{BW} = 20 \log \frac{1 \text{ MHz}}{100 \text{ kHz}} = 20$ dB

Note that various bandwidths (30 kHz, 100 kHz, and 300 kHz) have been used in the operation of the spectrum analyzer.

PHILA. HARBOR

Shipboard L-Band Terminal EMI Survey

MONDAY P.M.

Ship ALLIANCE Date 6/17/74 2152

Location STBD. F.B. Harbor X PHILADELPHIA At-Sea

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 0 dB Function DP. TOP F.I. BOTTOM TRACE Observer ED

Test Point (1) Filter Pos. NONE

4 FT. DISH ANT. WITH LOW LOSS LINE

Note BOTH RADARS OFF - AMBIENT

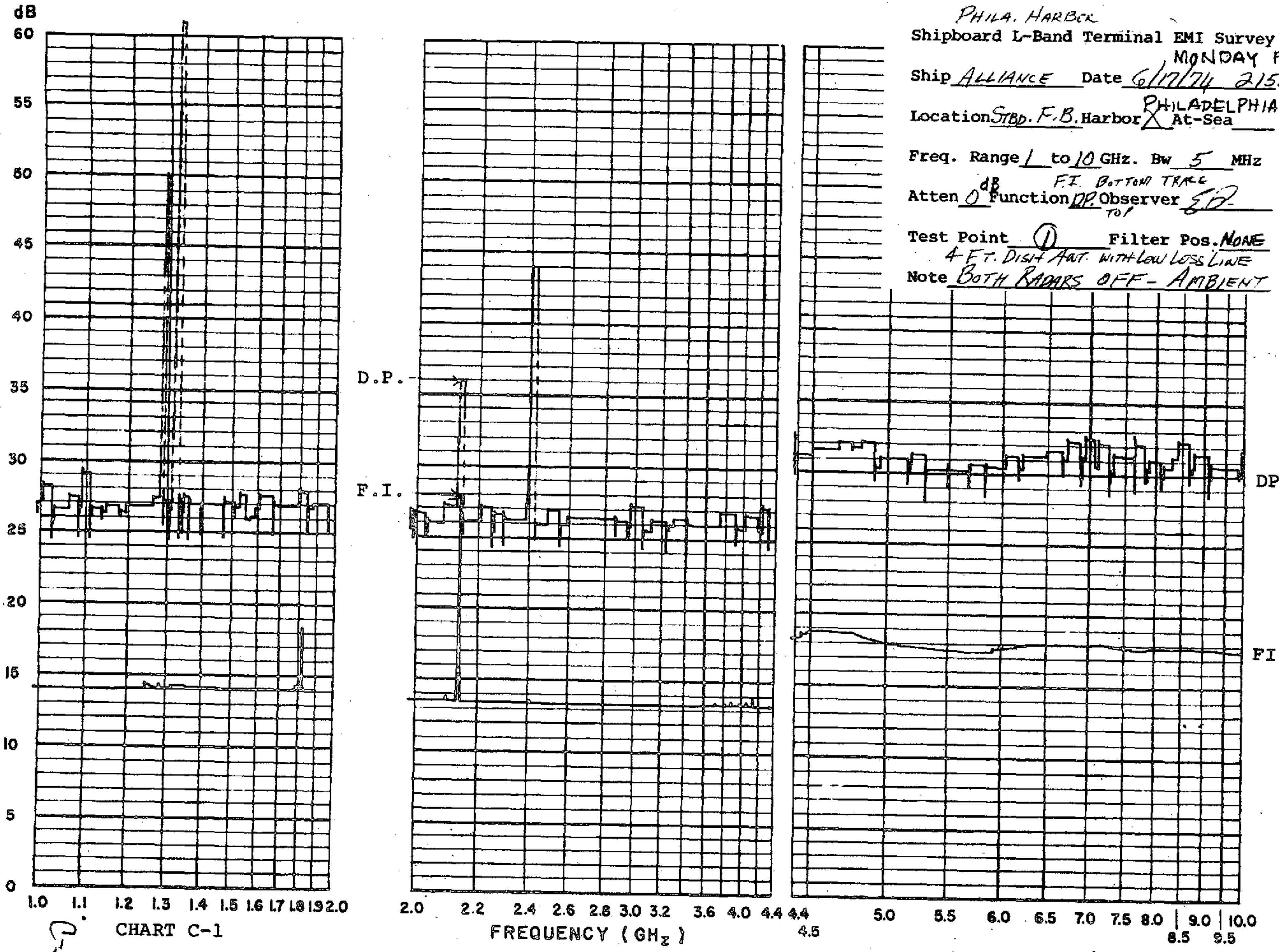


CHART C-1

65

HARBOR AMBIENT - PHILA.
Shipboard L-Band Terminal EMI Survey
TUESDAY A.M.

Ship ALLIANCE Date 6/18/74 0900HRS

Location F.B. STBD Harbor ✓ PHILADELPHIA At-Sea

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 0 dB Function F.I. Bottom D.P. Top Observer E.B.

Test Point (1) Filter Pos. NONE
4 FT. DISH ANT + LOWLOSS LINE

Note BOTH RADARS OFF

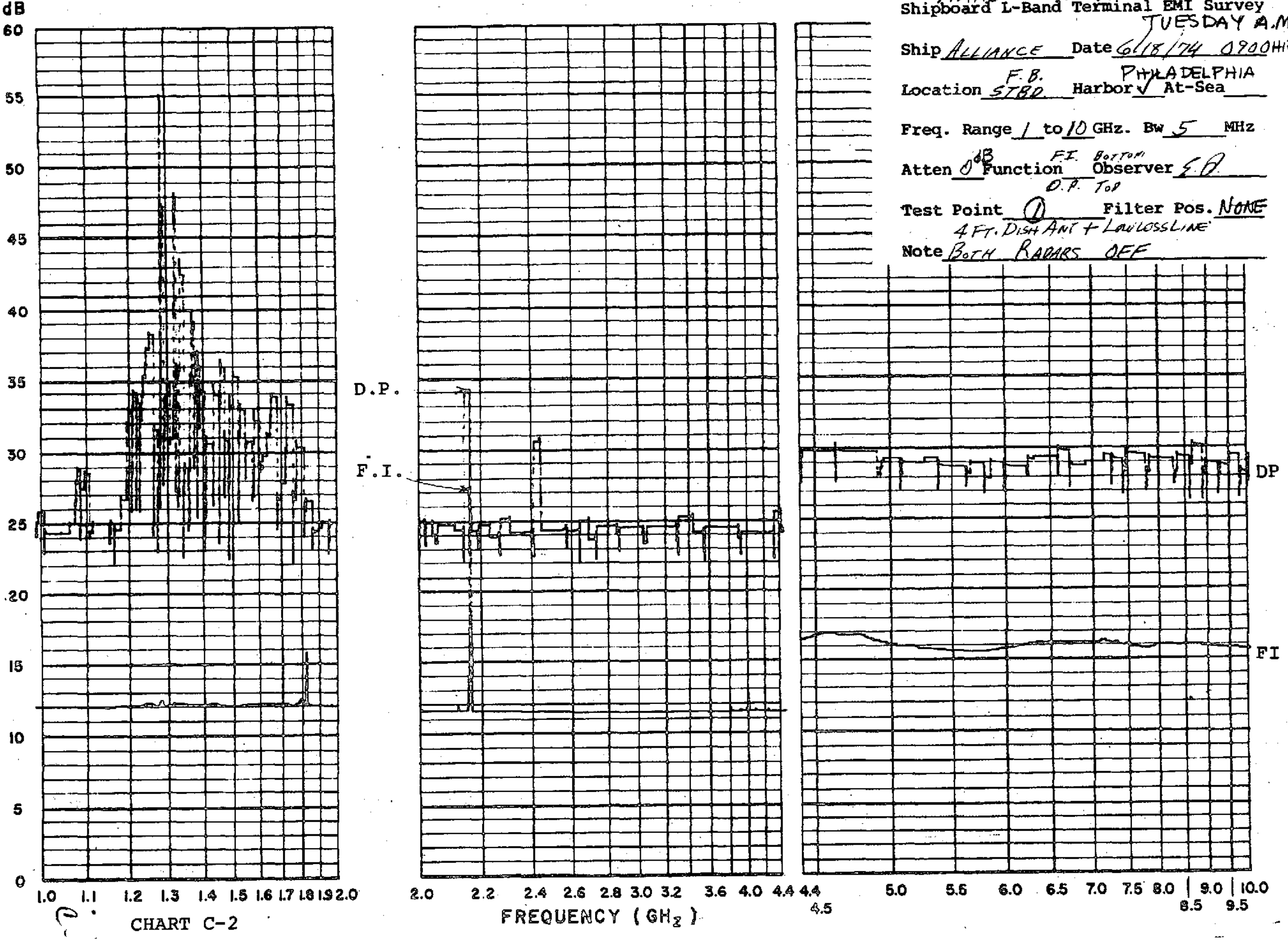


CHART C-2

C-9

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1215

Location 5T60 F.B. Harbor ___ At-Sea ✓

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 0 dB Function DP TOP / FI BOT Observer HILL/POWELL

Test Point 1 Filter Pos. NONE

Note 4 FT DISH POINTED AT RADAR ANTS. BOTH RADARS OFF

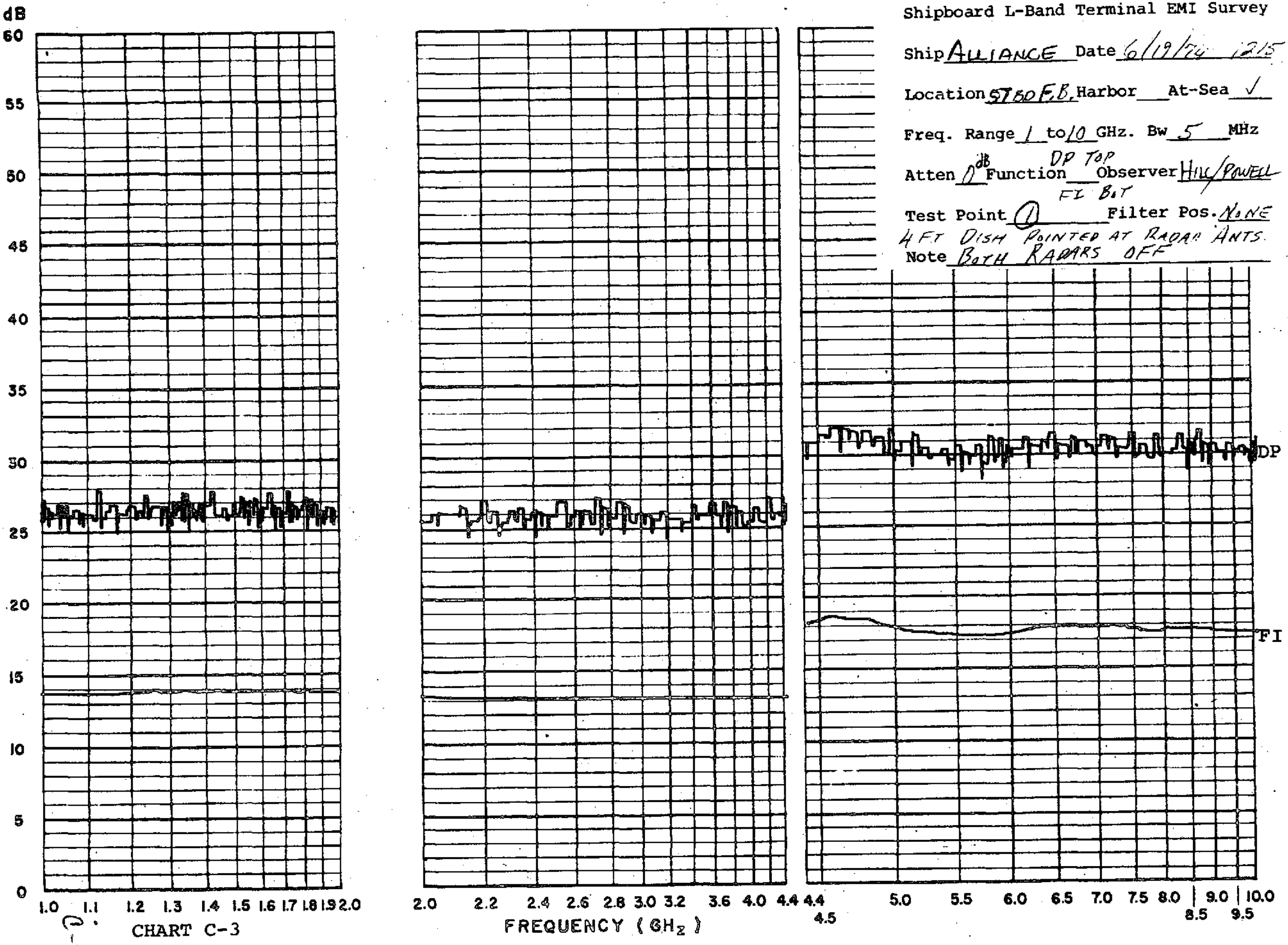


CHART C-3

C-7

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1520

Location STBD F.B. Harbor ___ At-Sea ✓

Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz

Atten 0 dB Function DP Top FI Bot Observer Hill/Powell

Test Point 1 Filter Pos. None

Note 4 FT DISH POINTED AT RADAR ANTS BOTH RADARS OFF

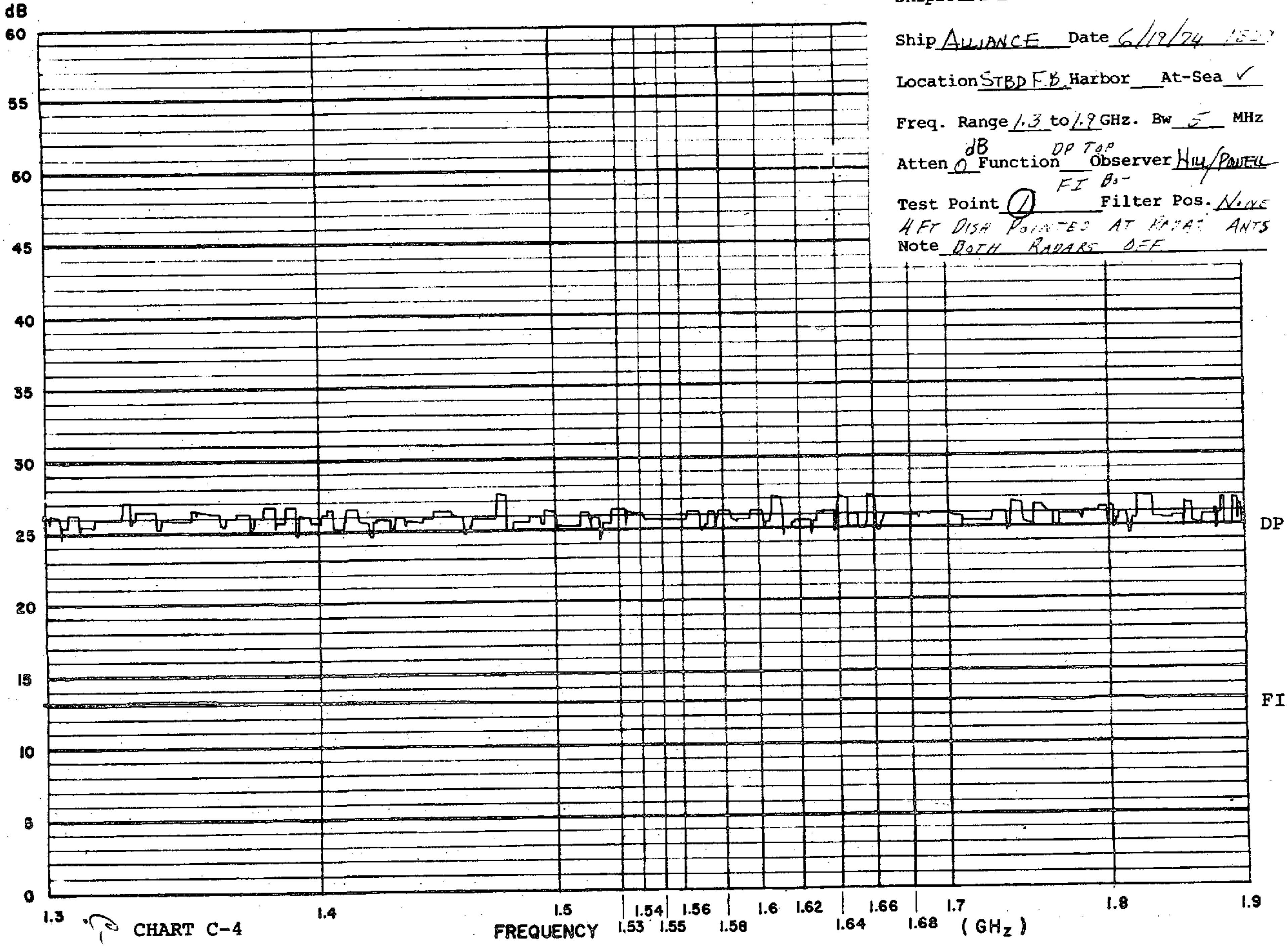
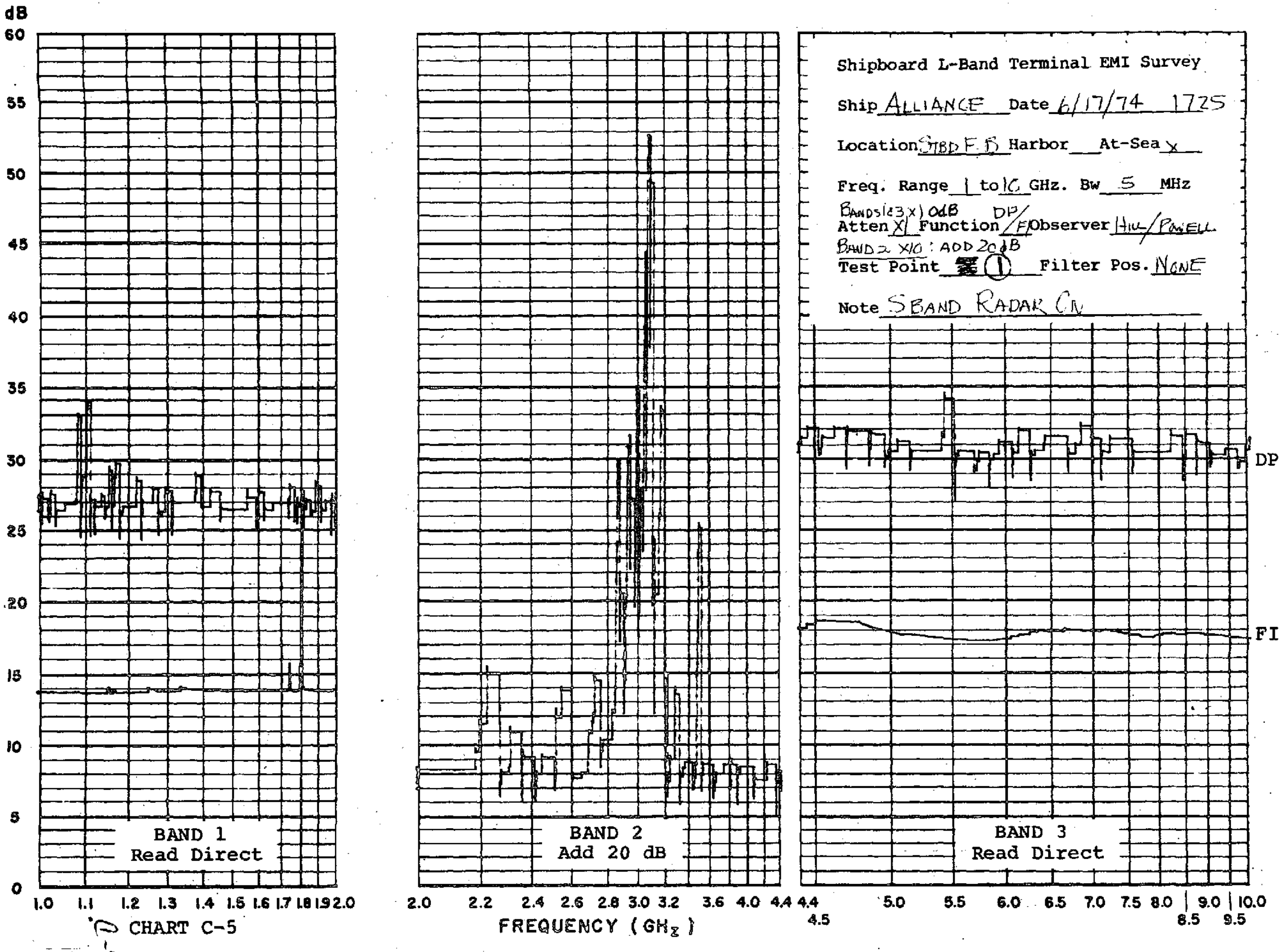


CHART C-4


Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/17/74 1725
Location STBD F.B. Harbor ___ At-Sea X
Freq. Range 1 to 10 GHz. Bw 5 MHz
BANDS (1&3 X) 0dB
Atten X1 Function DP/FI Observer HILL/POWELL
BAND 2 X10 : ADD 20dB
Test Point 1 Filter Pos. NONE
Note SBAND RADAR ON
dB
60
55
50
45
40
35
30
25
20
15
10
5
0
BAND 1
Read Direct
BAND 2
Add 20 dB
BAND 3
Read Direct
DP
FI
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)
CHART C-5

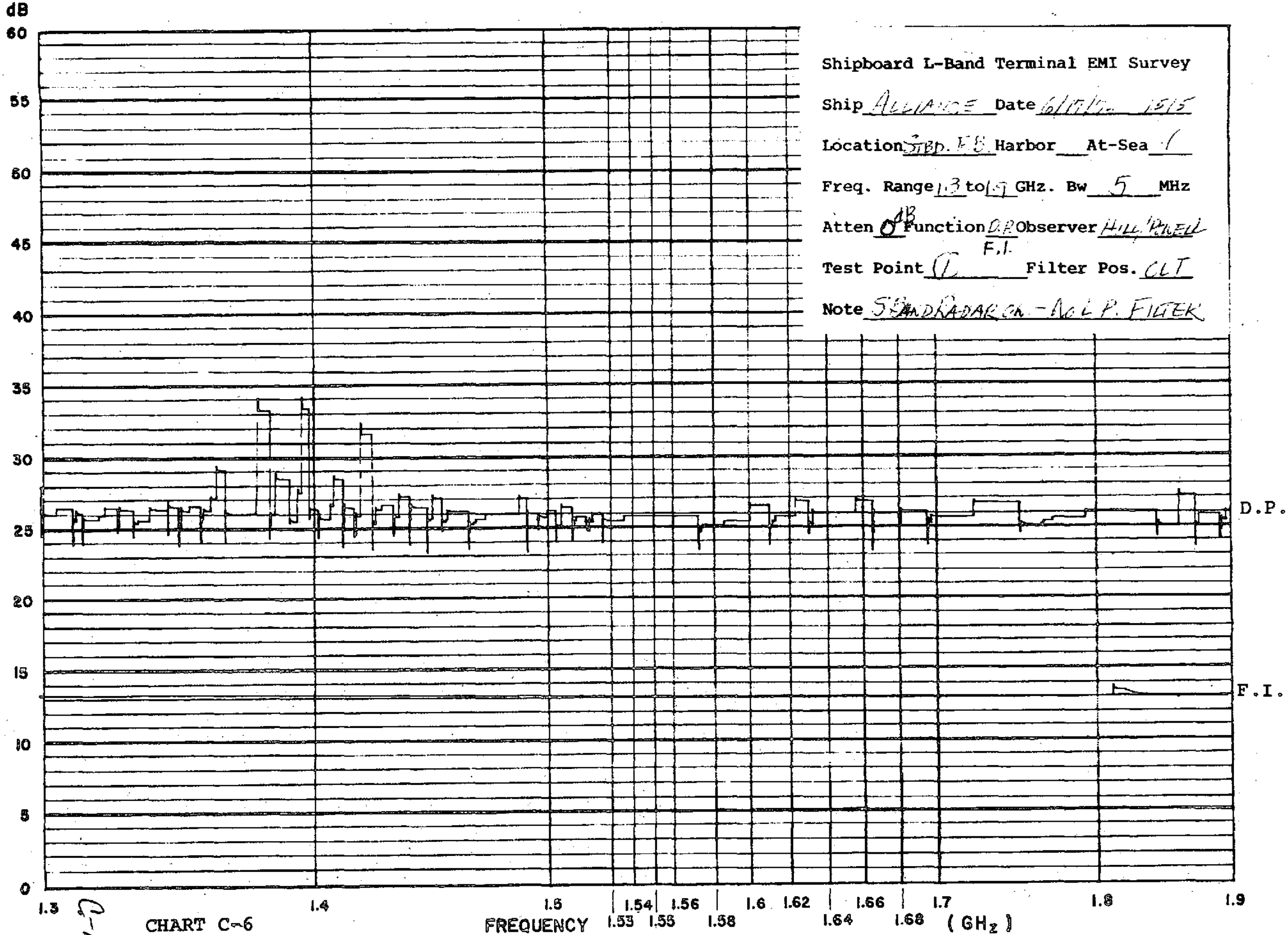

dB
60
55
50
45
40
35
30
25
20
15
10
5
0
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date
Location STBD. F.B. Harbor At-Sea
Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz
Atten 0 dB Function D.P. F.I. Observer
Test Point Filter Pos.
Note
D.P.
F.I.
1.3
1.4
1.5
1.53
1.54
1.55
1.56
1.58
1.6
1.62
1.64
1.66
1.68
1.7
1.8
1.9
FREQUENCY (GHz)

CHART C-6

C-10

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/7_ 1400

Location STBD F.B. Harbor ___ At-Sea ✓

Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz

Atten 0 dB Function DP TOP FT BI Observer HILL/POWELL

Test Point 1 Filter Pos. None

Note BOTH RADARS ON. 4-5 DISH ... AT RADAR ... ~~As Stored~~

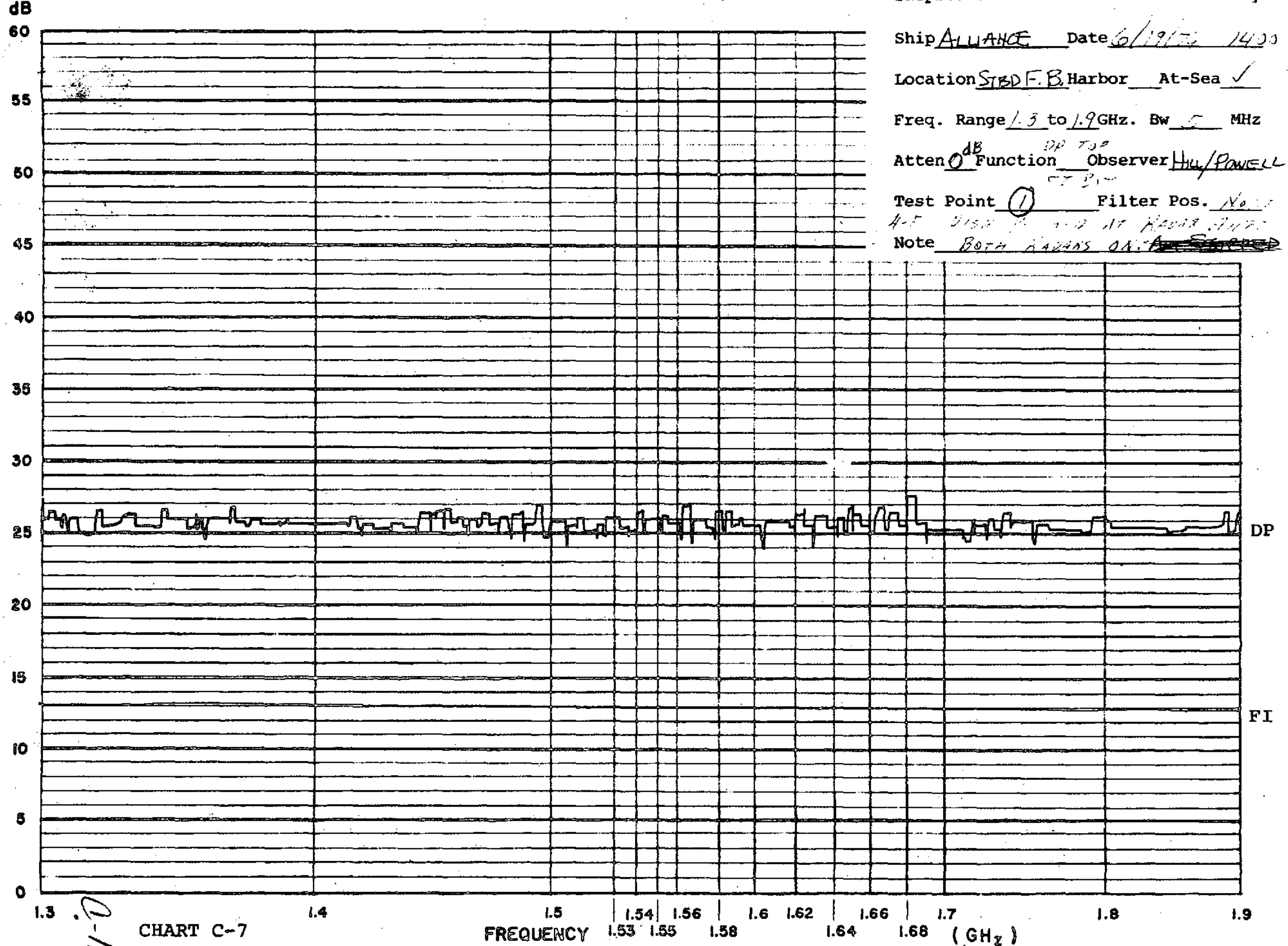
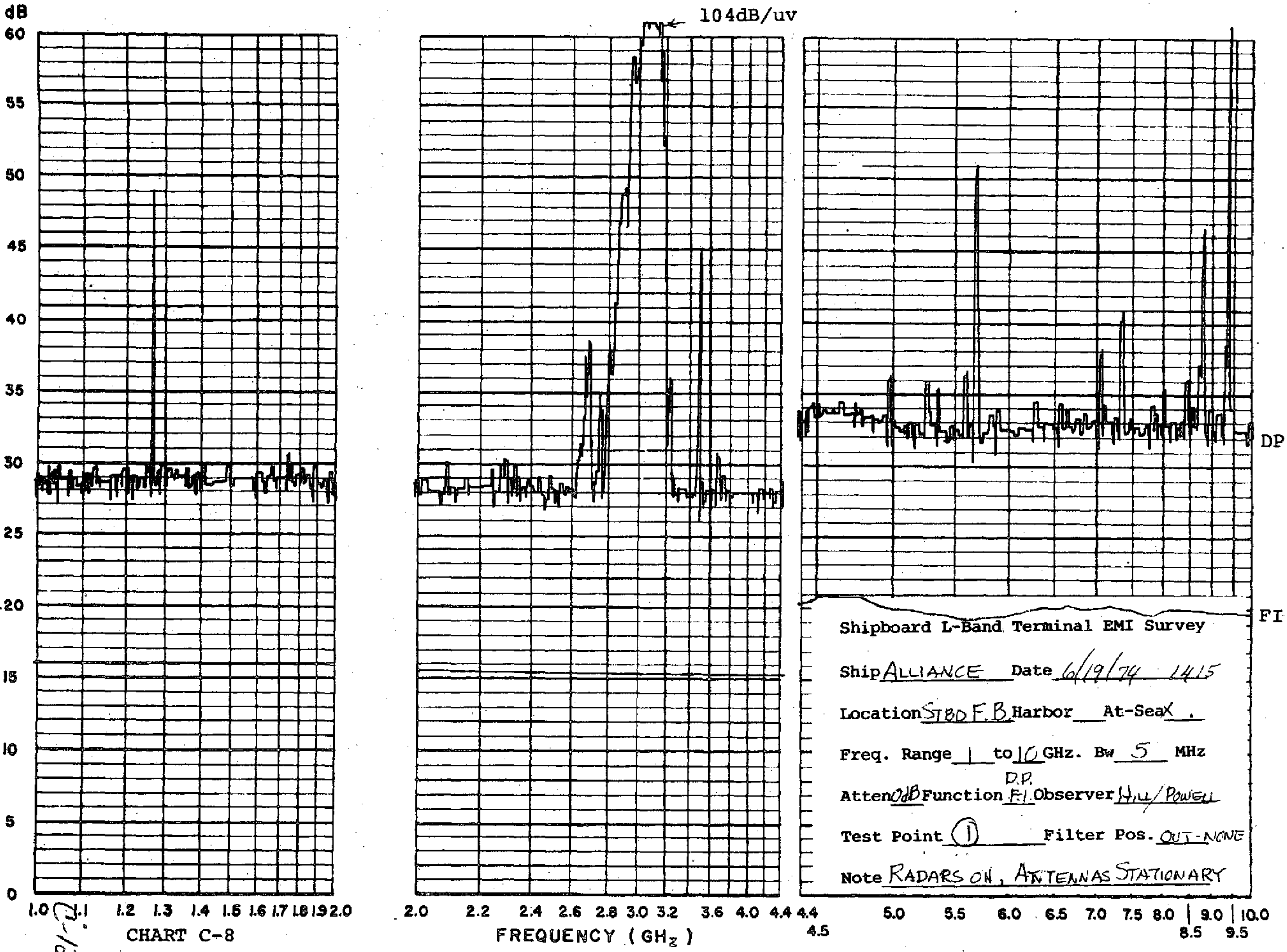


CHART C-7

D-11


dB
60
55
50
45
40
35
30
25
20
15
10
5
0
104dB/uv
DP
FI
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
CHART C-8
FREQUENCY (GHz)
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/19/74 1415
Location STBD F.B. Harbor ___ At-Sea X .
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 0dB Function D.P. F.I Observer HILL/POWELL
Test Point 1 Filter Pos. OUT-NONE
Note RADARS ON, ANTENNAS STATIONARY

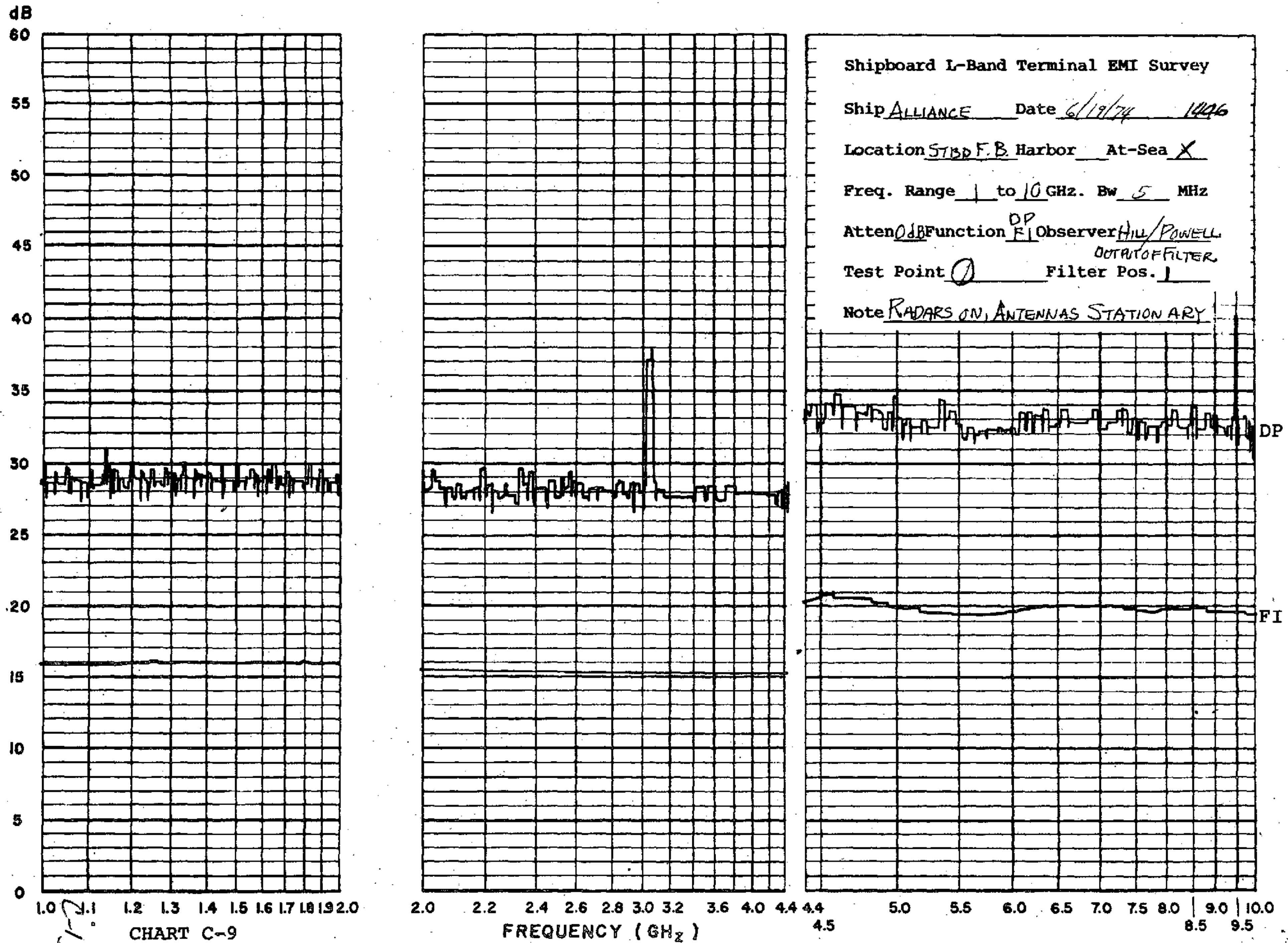

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/19/74 1406
Location STBD F.B. Harbor At-Sea X
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 0dB Function DP F I Observer HILL/POWELL
OUTPUT OF FILTER
Test Point (1) Filter Pos. 1
Note RADARS ON, ANTENNAS STATIONARY
dB
60
55
50
45
40
35
30
25
20
15
10
5
0
DP
FI
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)

CHART C-9

C-13

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date [illegible] 1205

Location STBD F.B Harbor ___ At-Sea ✓

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 0 dB Function DP Top / FI Bi Observer [illegible]

Test Point 2 Filter Pos. NONE

Note 4-FT DISH [illegible] BOTH RADARS [illegible]

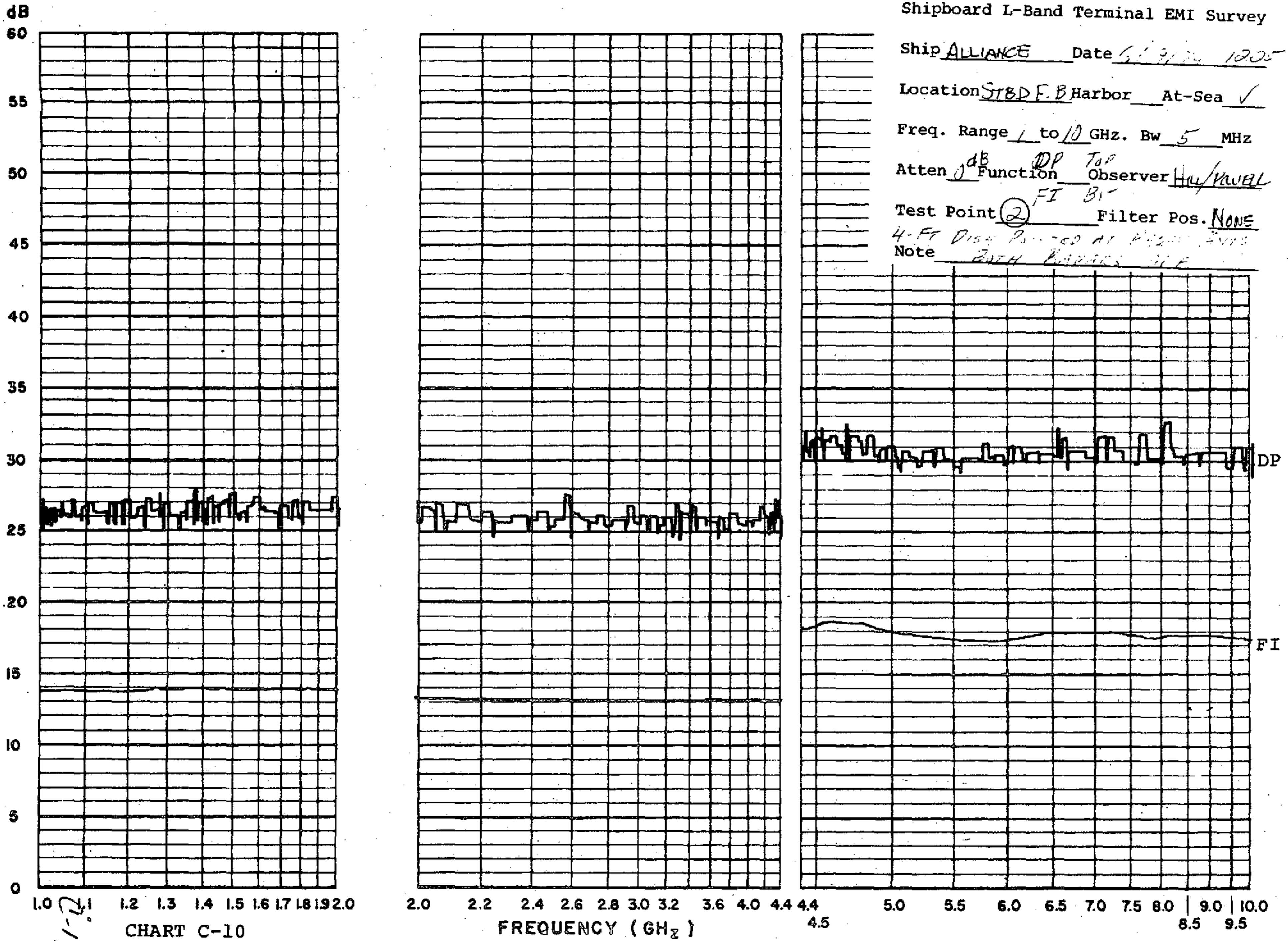


CHART C-10

H-12

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1343

Location STBD F.B. Harbor ___ At-Sea √

Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz

Atten 0 dB Function DP TOP FI BOT Observer HILL/PAVELL

Test Point ② Filter Pos. None

Note 4 FT DISH VISITED AT RADAR ANTS BOTH RADARS OFF

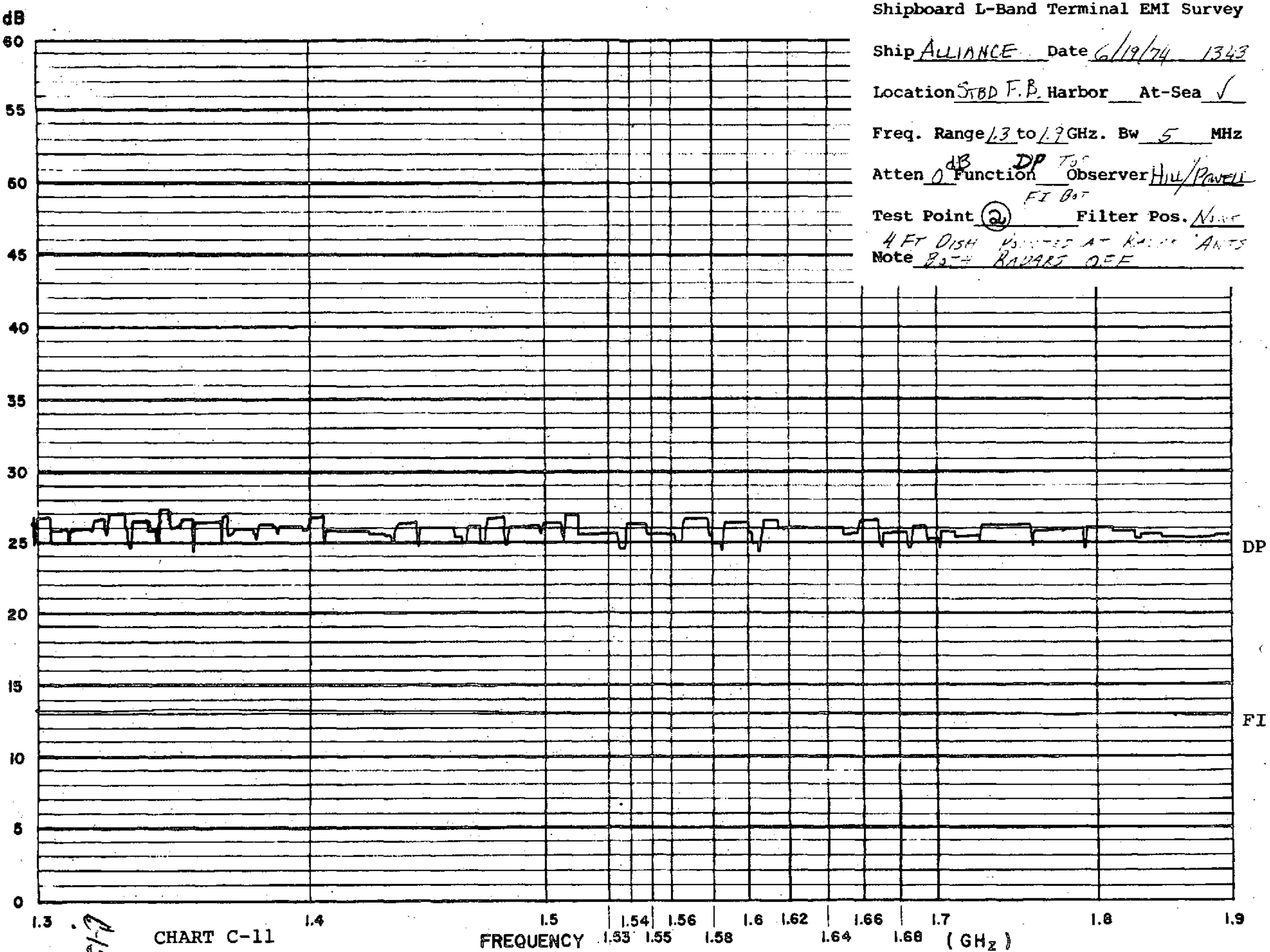


CHART C-11

6-15

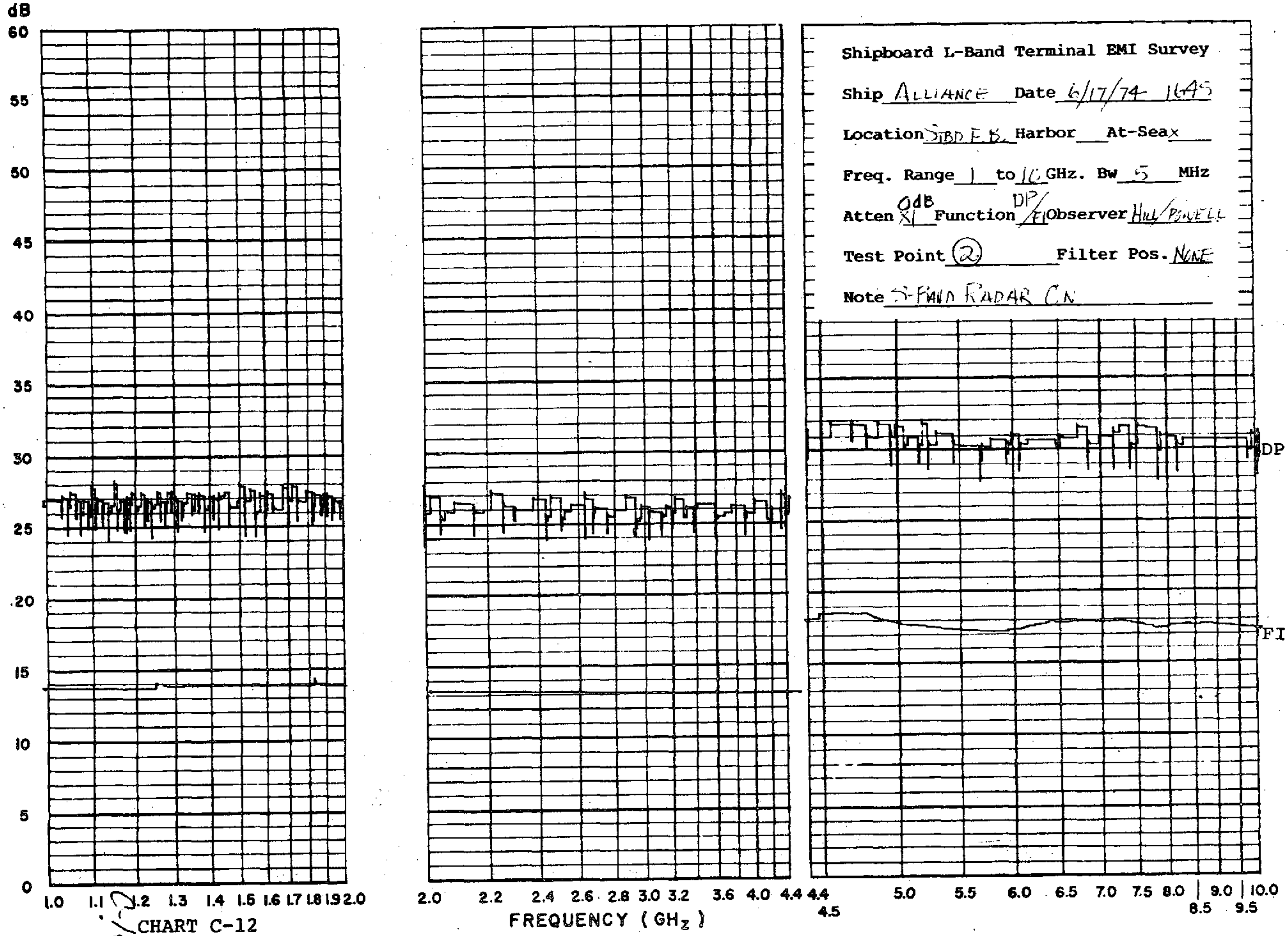

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/17/74 1645
Location SIBD E.B. Harbor ___ At-Sea x
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten X1 0dB Function DP/FI Observer HILL/POWELL
Test Point (2) Filter Pos. NONE
Note S-BAND RADAR ON
dB
60
55
50
45
40
35
30
25
20
15
10
5
0
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)
DP
FI

CHART C-12

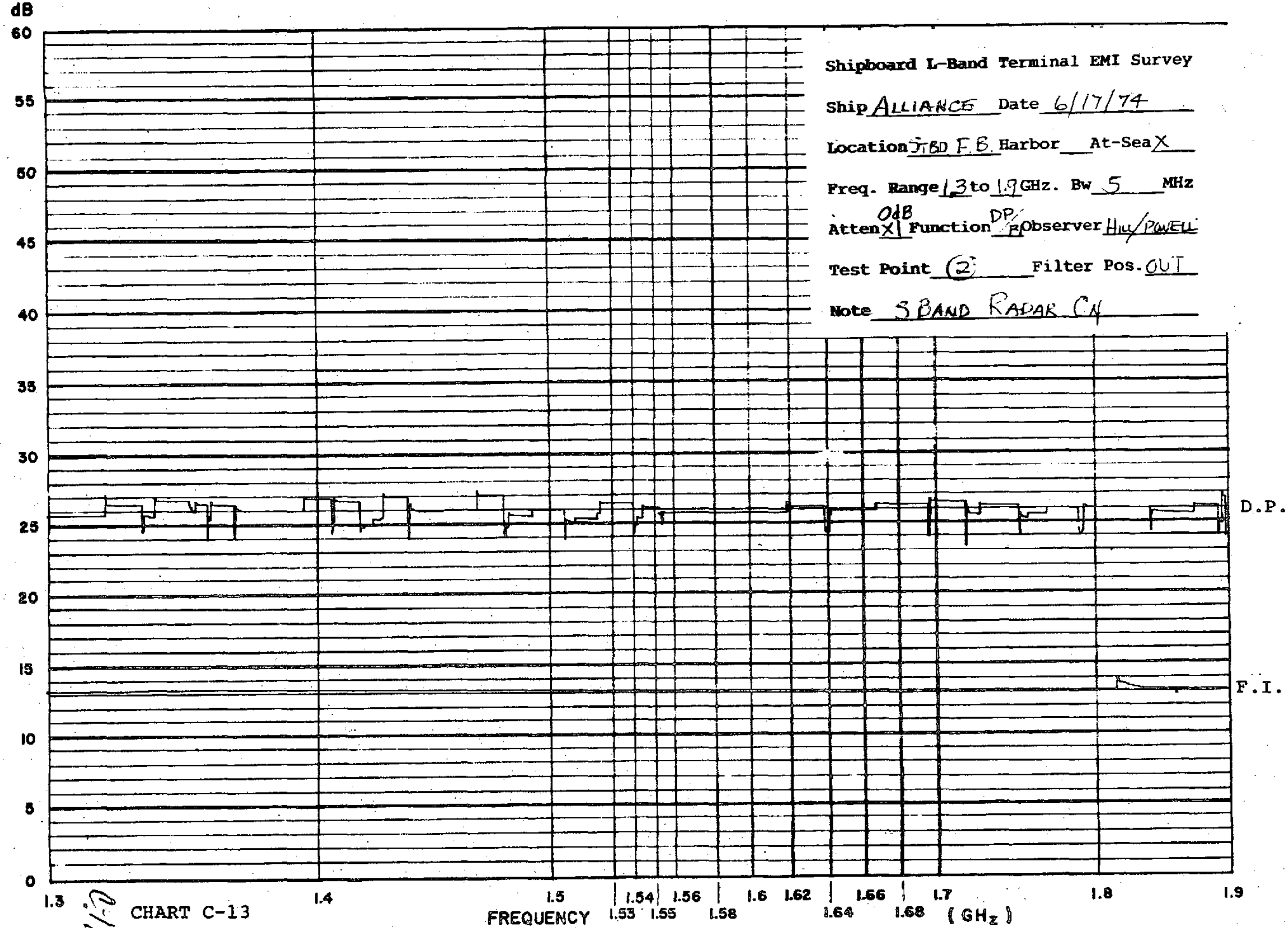
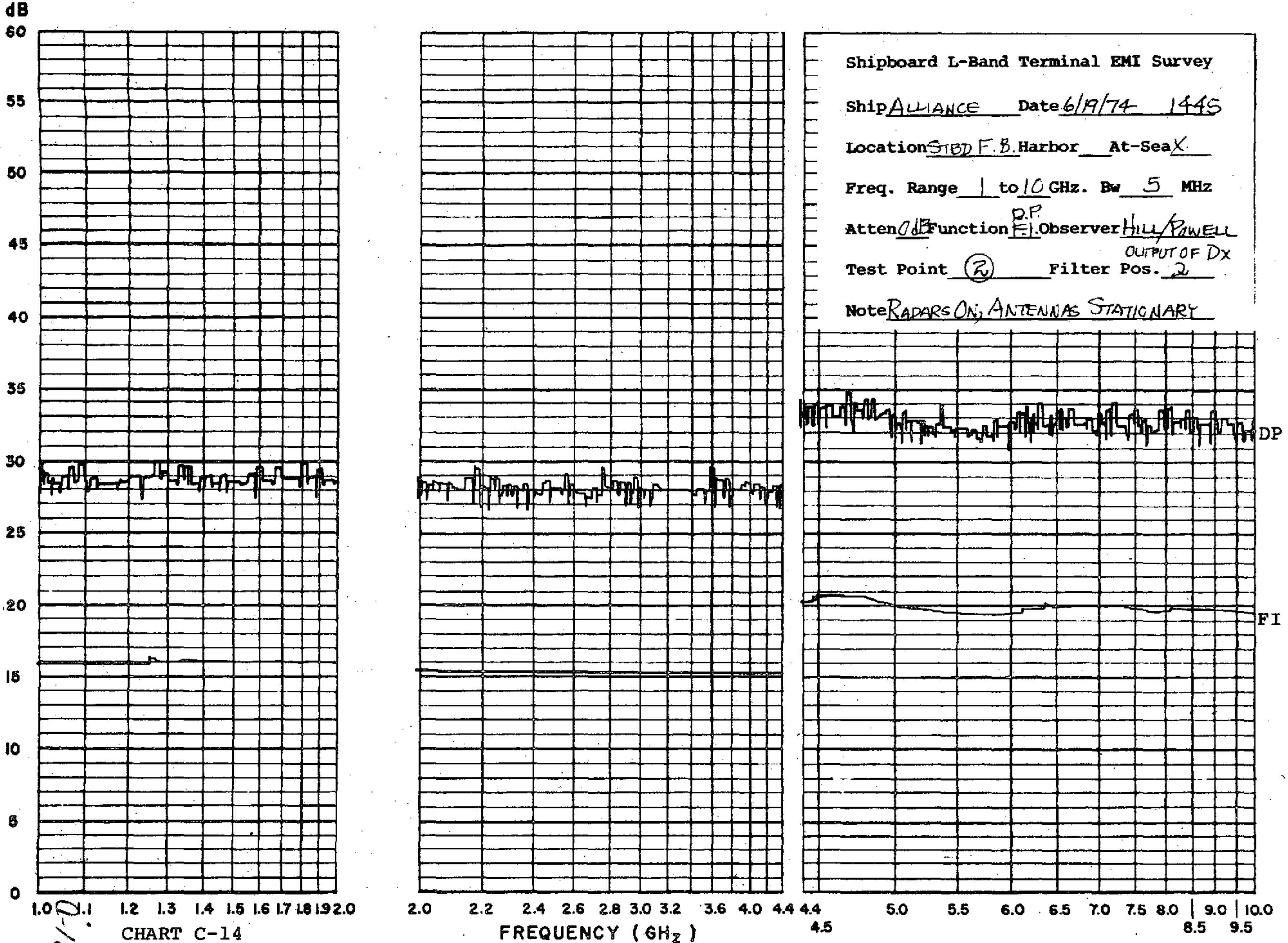
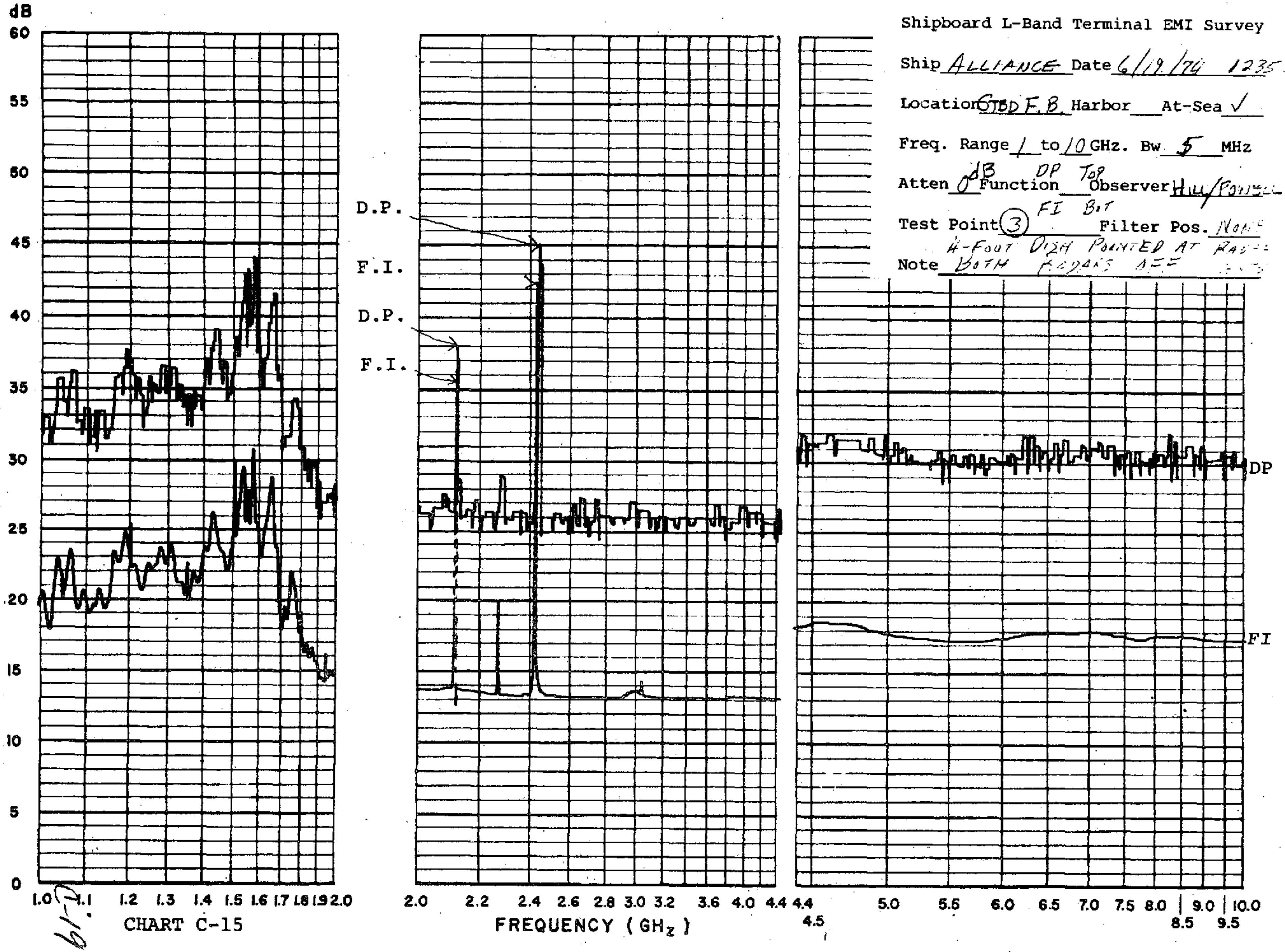

Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/17/74
Location JTBD F.B. Harbor ___ At-Sea X
Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz
Atten X1 0dB Function DP/FI Observer HILL/POWELL
Test Point (2) Filter Pos. OUT
Note S BAND RADAR ON
dB
60
55
50
45
40
35
30
25
20
15
10
5
0
D.P.
F.I.
1.3
1.4
1.5
1.53
1.54
1.55
1.56
1.58
1.6
1.62
1.64
1.66
1.68
1.7
1.8
1.9
FREQUENCY (GHz)

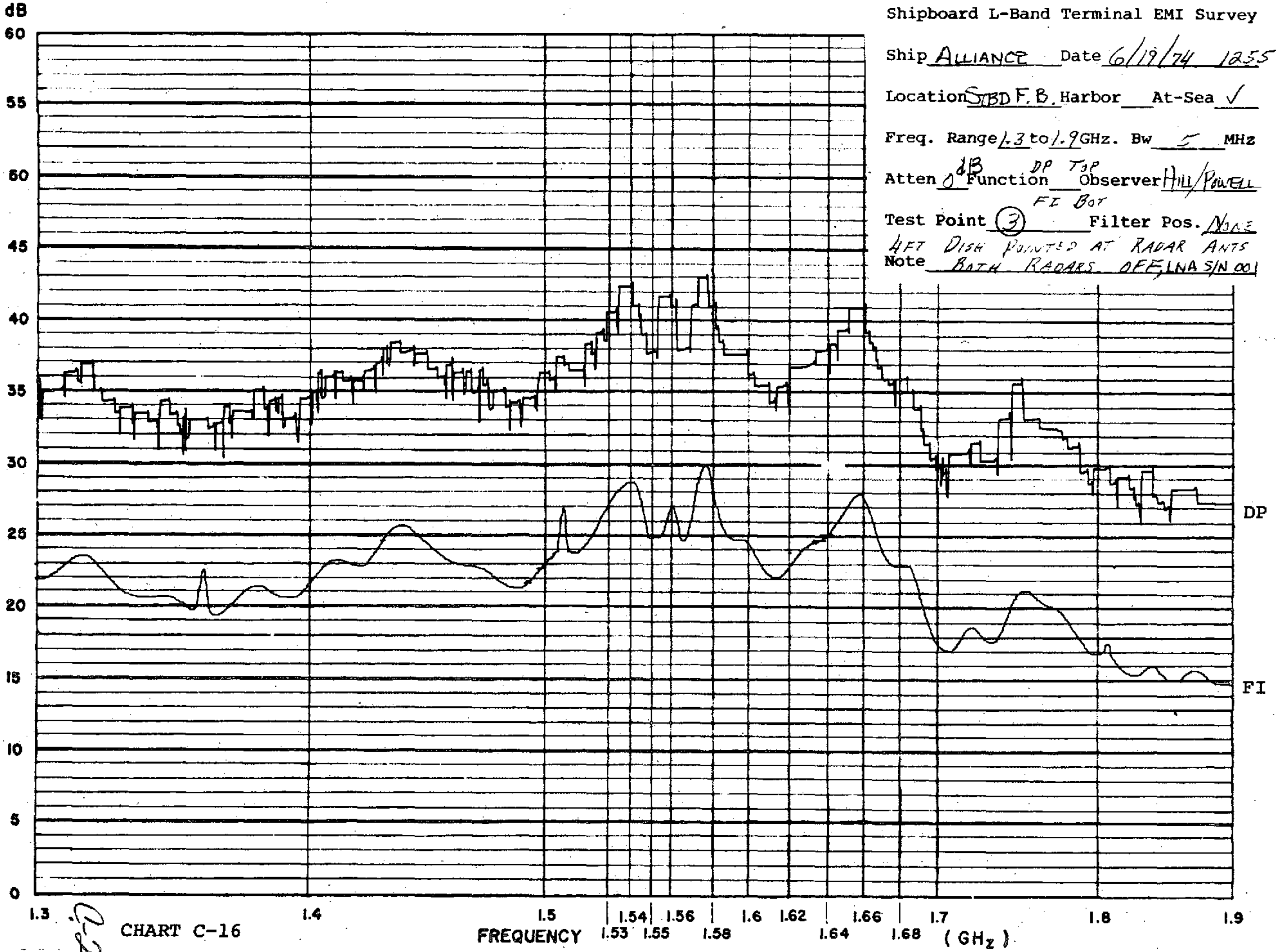
CHART C-13



Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/19/74 1445
Location STBD F.B. Harbor At-Sea X
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 0 dB Function D.P. F.I. Observer HILL/POWELL
OUTPUT OF Dx
Test Point (2) Filter Pos. 2
Note RADARS ON, ANTENNAS STATIONARY
dB
60
55
50
45
40
35
30
25
20
15
10
5
0
DP
FI
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.6
4.0
4.4
4.4
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
FREQUENCY (GHz)

CHART C-14


Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/19/74 1235
Location GTBD F.B. Harbor At-Sea ✓
Freq. Range 1 to 10 GHz. Bw 5 MHz
Atten 0 dB Function DP Top FI Bot Observer Hill/Powell
Test Point 3 Filter Pos. None
Note Both radars off 4-foot dish pointed at radar
dB
60
55
50
45
40
35
30
25
20
15
10
5
0
D.P.
F.I.
D.P.
F.I.
DP
FI
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.6 4.0 4.4
4.4 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
FREQUENCY (GHz)
CHART C-15
C-19



C-20

CHART C-16

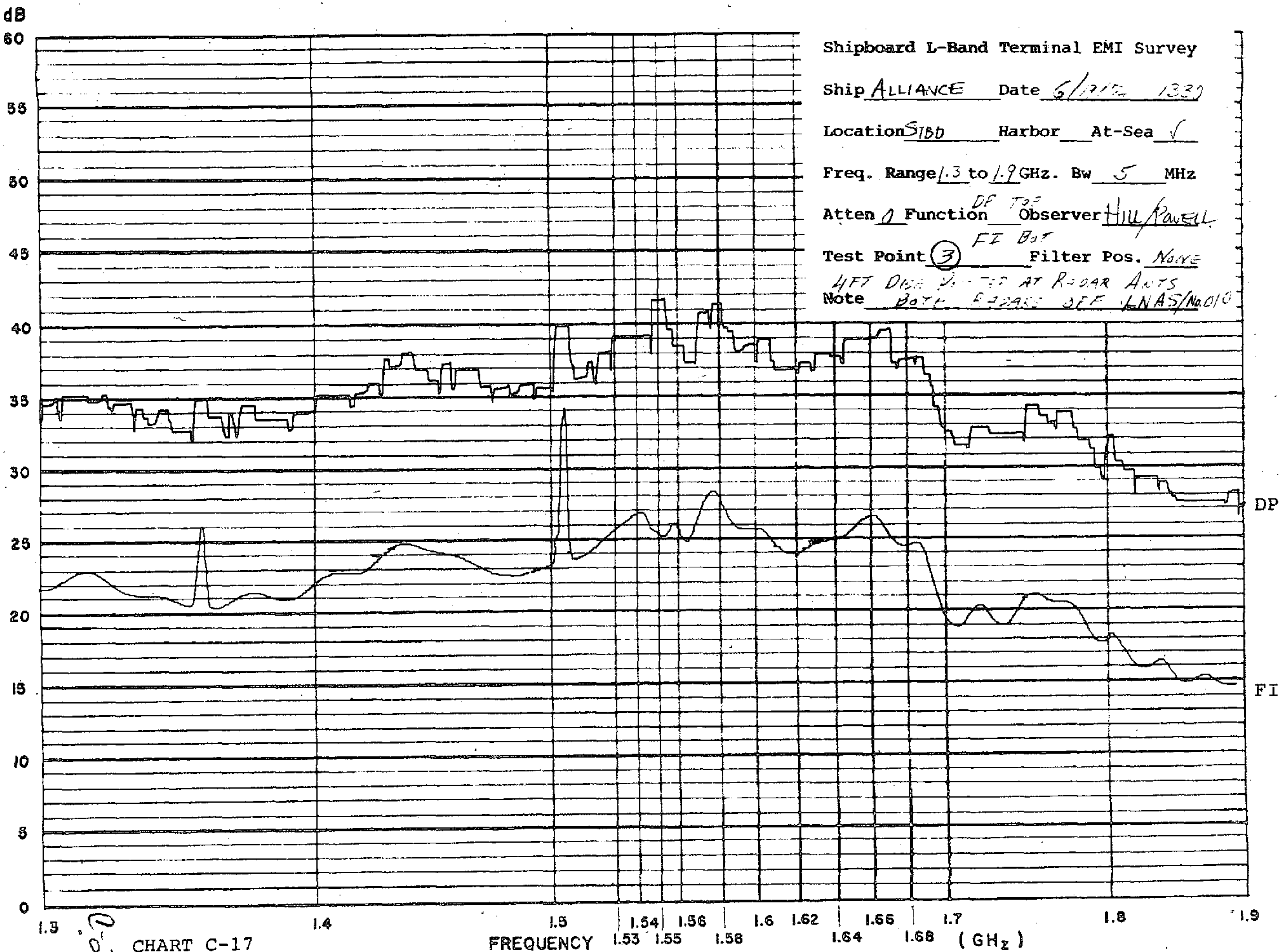

dB
60
55
50
45
40
35
30
25
20
15
10
5
0
Shipboard L-Band Terminal EMI Survey
Ship ALLIANCE Date 6/ 1330
Location SIBD Harbor At-Sea √
Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz
Atten 0 Function DF TOP FI BOT Observer Hill/Powell
Test Point 3 Filter Pos. None
Note 4FT DISH AT RADAR ANTS BOTH RADARS OFF LNAS/No.010
DP
FI
1.3
1.4
1.5
1.53
1.54
1.55
1.56
1.58
1.6
1.62
1.64
1.66
1.68
1.7
1.8
1.9
FREQUENCY
(GHz)

CHART C-17

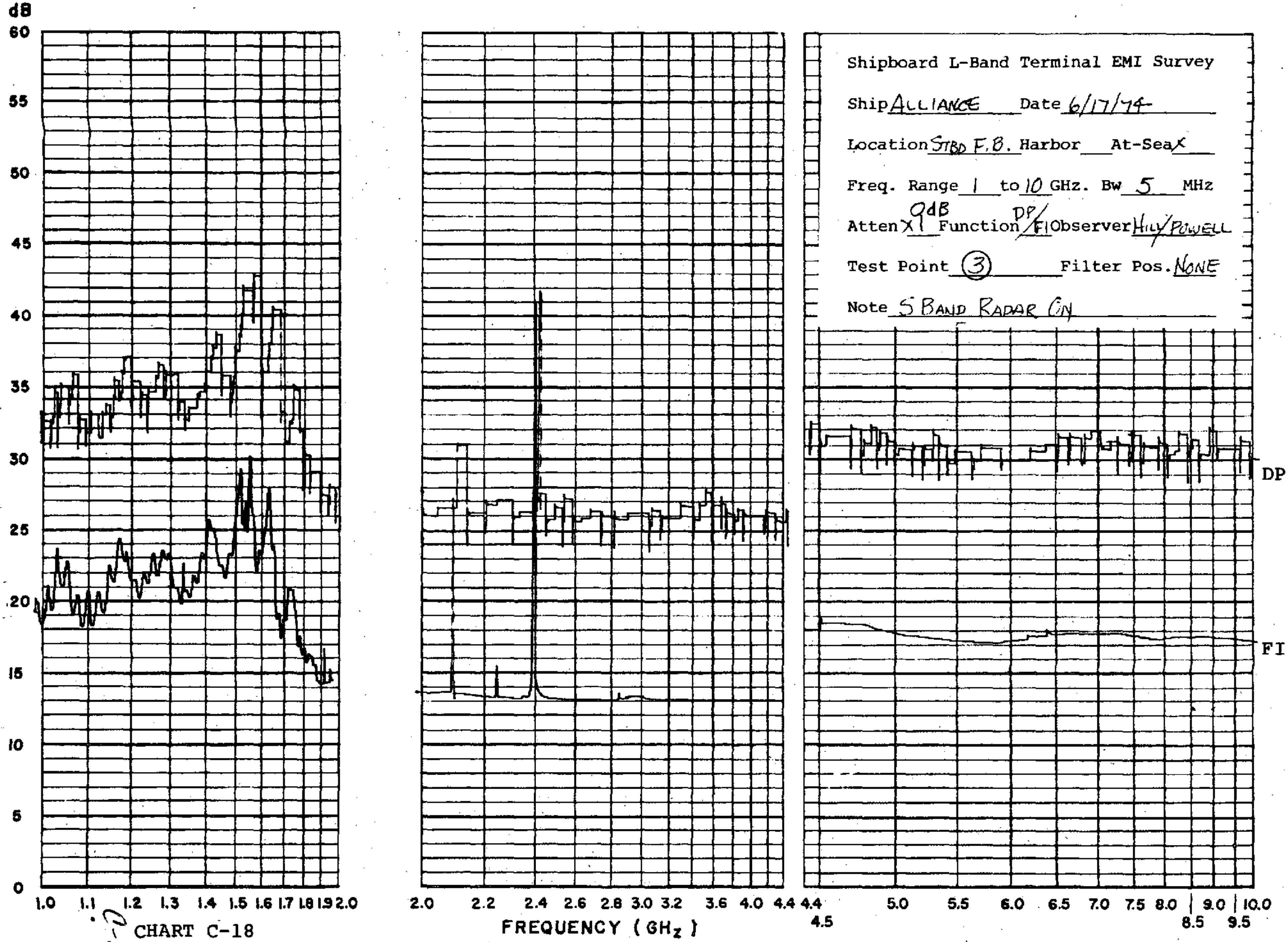


CHART C-18

C-22

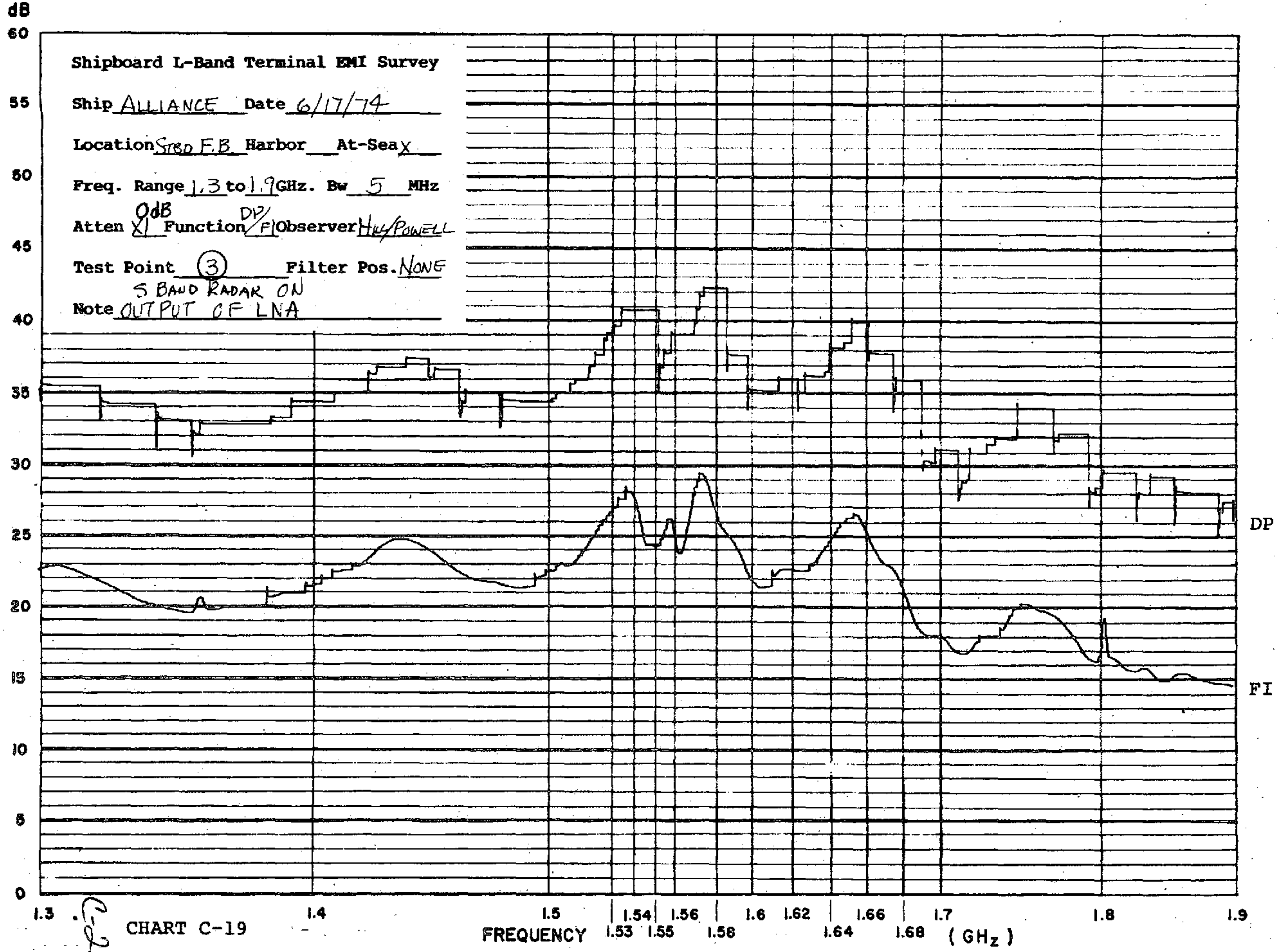


CHART C-19

C-23

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 2230

Location STBD. F.B. Harbor √ PHILADELPHIA At-Sea

Freq. Range 1 to 10 GHz. Bw 5 MHz

Atten 0 dB Function FI BOT. DP TOP Observer ED

Test Point 3 Filter Pos. NONE

Note OUTPUT OF LNA

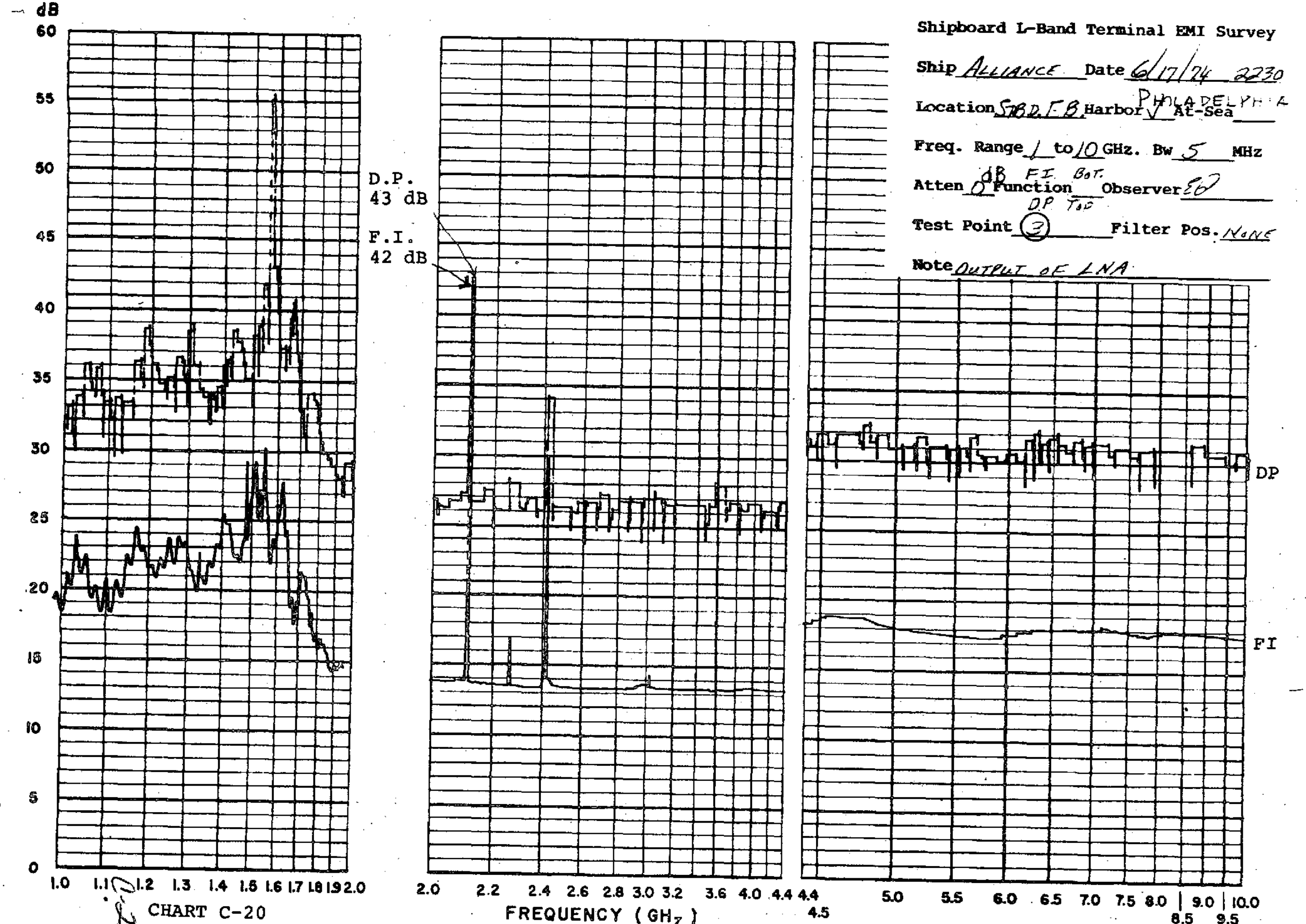


CHART C-20

C-24

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 13:..

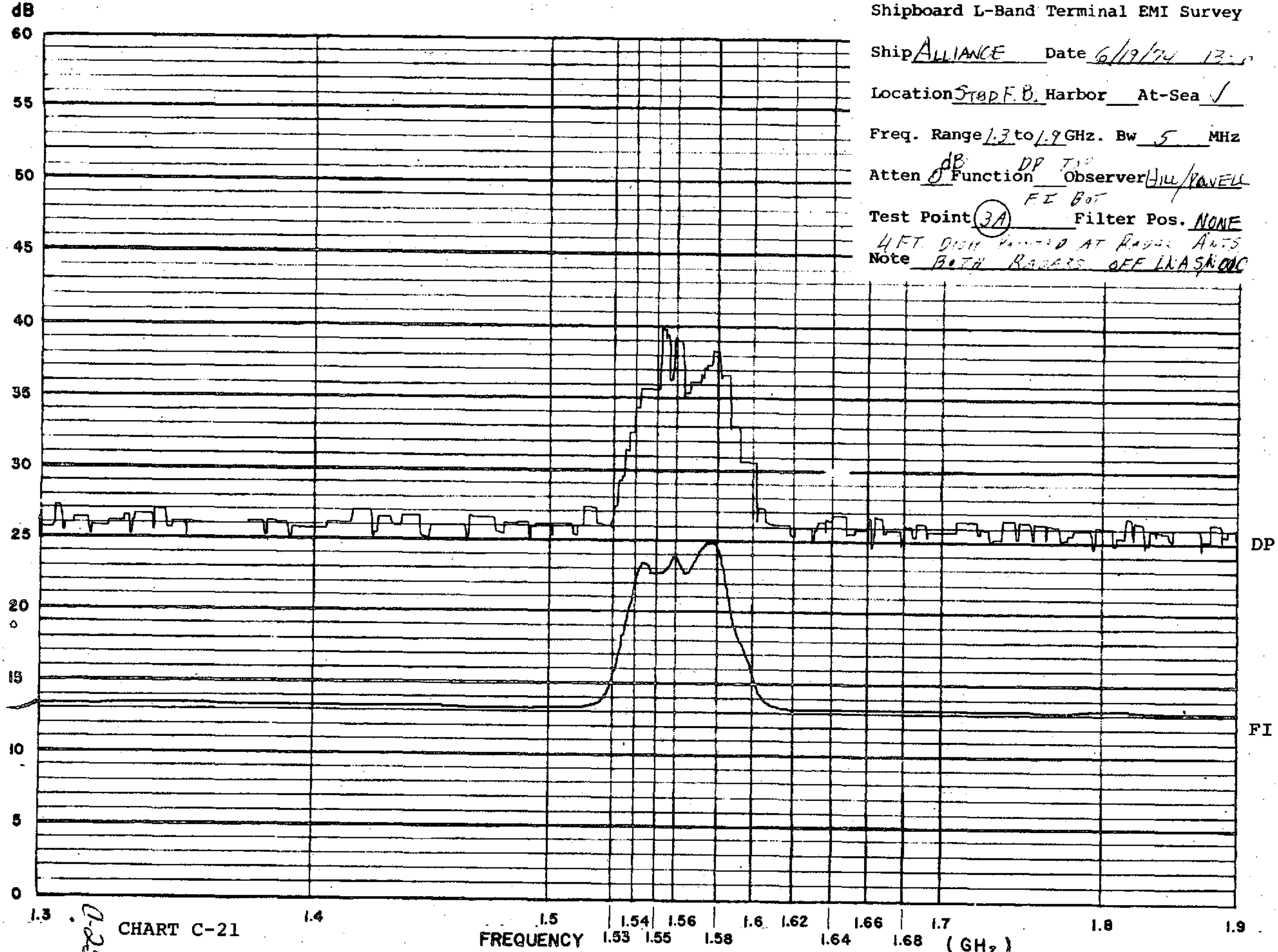
Location STBD F.B. Harbor ___ At-Sea ✓

Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz

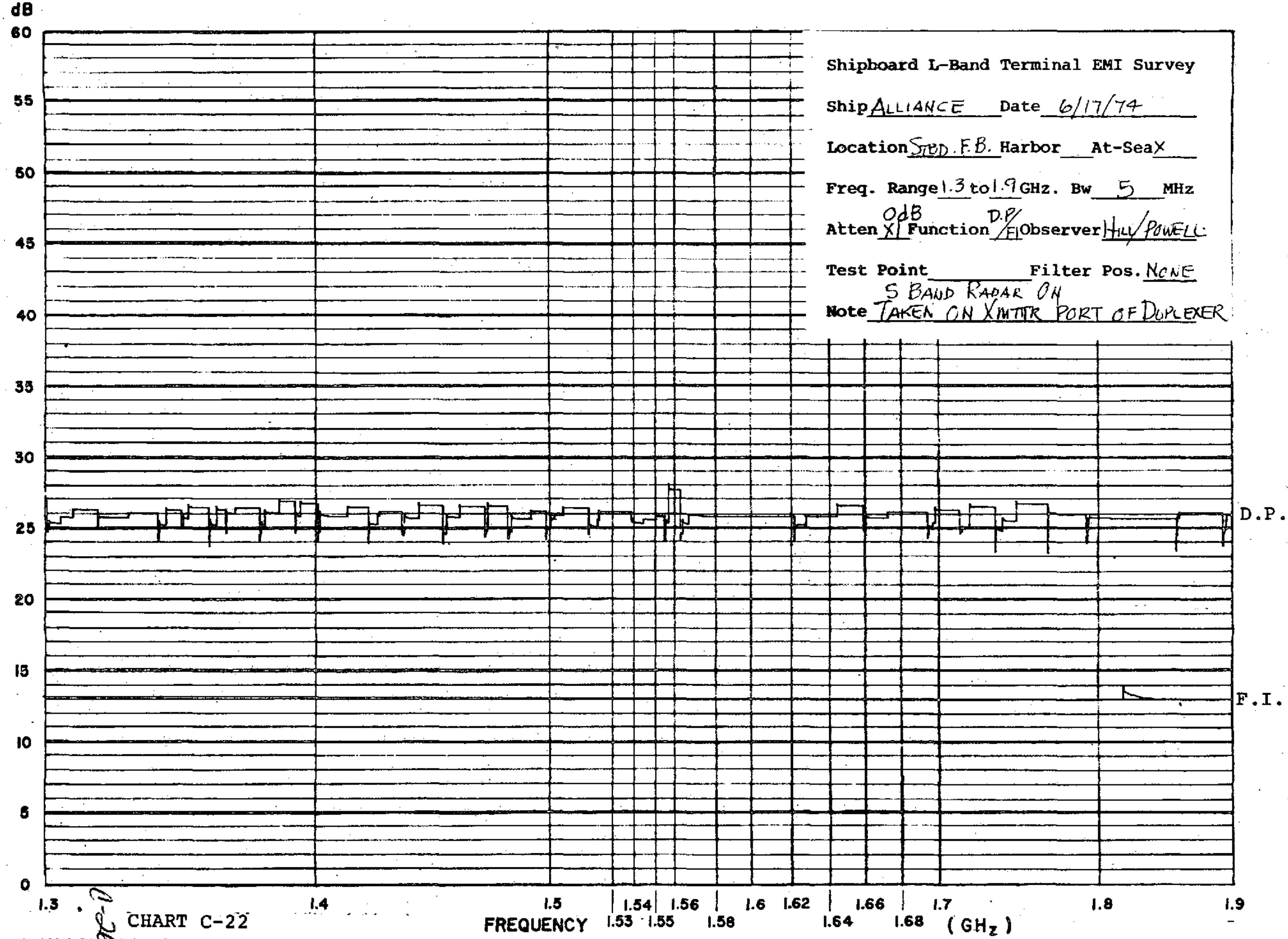
Atten 0 dB Function DP TOP / FI BOT Observer HILL/POWELL

Test Point 3A Filter Pos. NONE

Note 4 FT DISH POINTED AT RADAR ANTS / BOTH RADARS OFF



0-25 CHART C-21



Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74

Location STBD. F.B. Harbor ___ At-Sea X

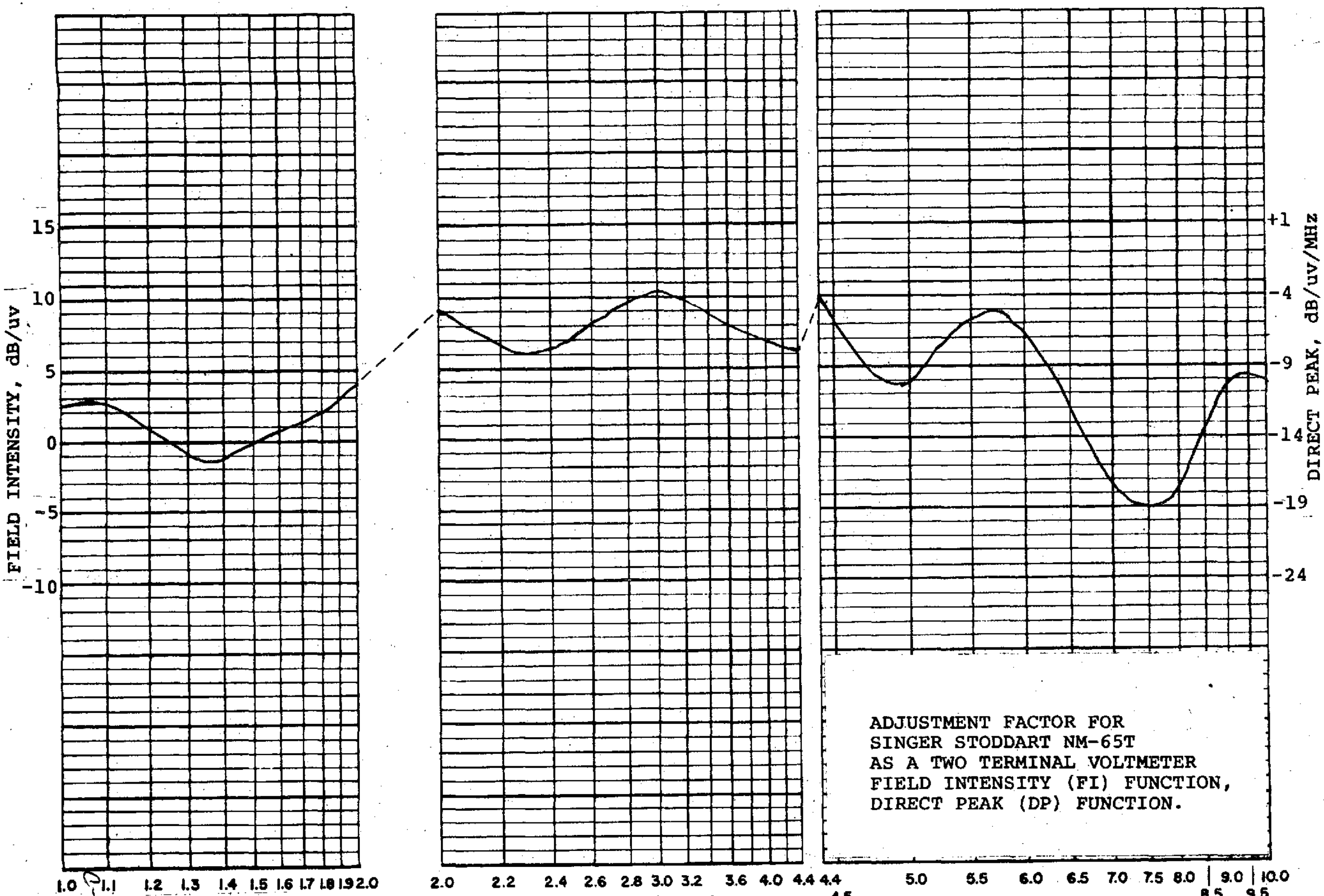
Freq. Range 1.3 to 1.9 GHz. Bw 5 MHz

Atten X/ 0dB Function D.P/F.I Observer HILL/POWELL

Test Point ________ Filter Pos. NONE

Note S BAND RADAR ON TAKEN ON XMTTR PORT OF DUPLEXER

CHART C-22



ADJUSTMENT FACTOR FOR
SINGER STODDART NM-65T
AS A TWO TERMINAL VOLTMETER
FIELD INTENSITY (FI) FUNCTION,
DIRECT PEAK (DP) FUNCTION.

CHART C-23

Spectrum Display C-1

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 2020 ~~1955~~

2.07 TO 6.15 GHz FULL BAND

Center Freq.___MHz, Bandwidth 300 KHz

Scan Width__MHz/div, Log Ref Level -20 dBm

Test Point #1 4FT DISH Filter Pos. NONE

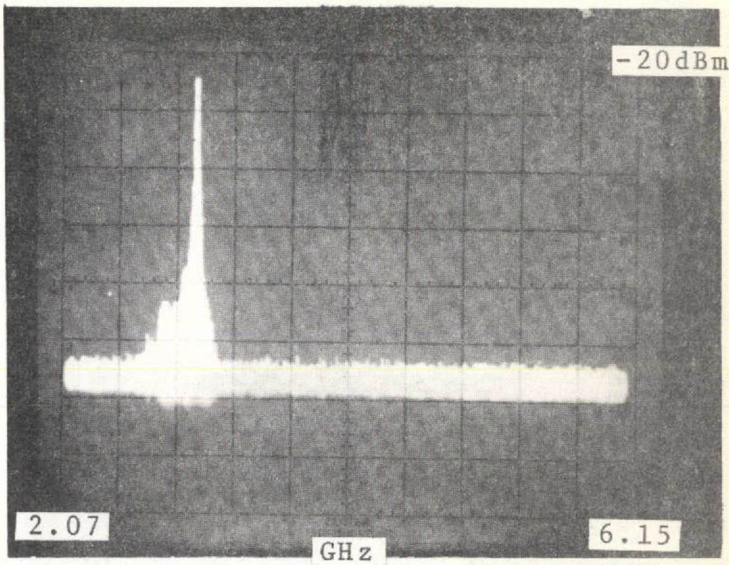
S-BAND RADAR INTO 4FT. DISH.

Location STBD F.B. Harbor______ At-Sea X

RADAR ANT. STATIONARY.

Date______ Note______ Observer HILL/POWELL

PHOTO C-1



Spectrum Display C-2

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 2115 ~~1956~~

Center Freq.___MHz, Bandwidth 300 KHz

6.17 TO 10.25 GHz FULL BAND

Scan Width__MHz/div, Log Ref Level -30 dBm

X-BAND RADAR INTO 4FT. DISH ANT.

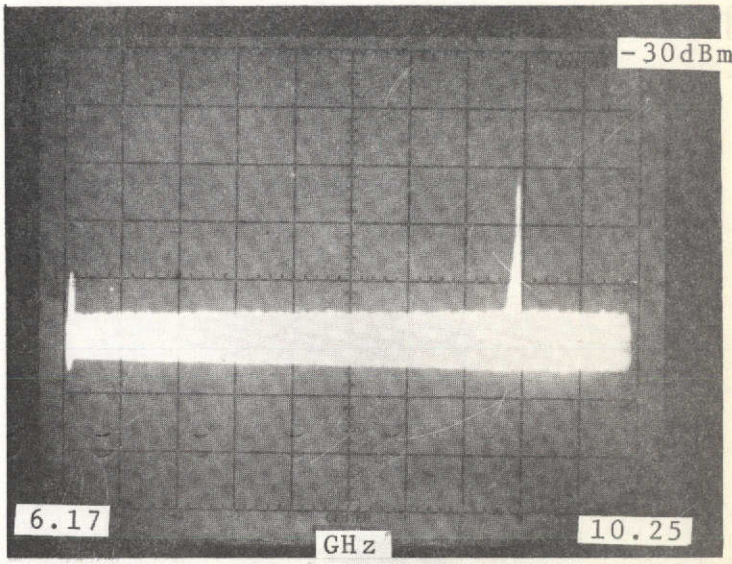
Test Point #1 4FT DISH Filter Pos. NONE

Location STBD F.B. Harbor______ At-Sea X

RADAR ANT. STAIONARY

Date______ Note 5 SEC/DIV Observer______

PHOTO C-2



Spectrum Display C-3

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1715

Center Freq. 1.5 GHz, Bandwidth 100 KHz

Scan Width 200 MHz/div, Log Ref Level -40 dBm

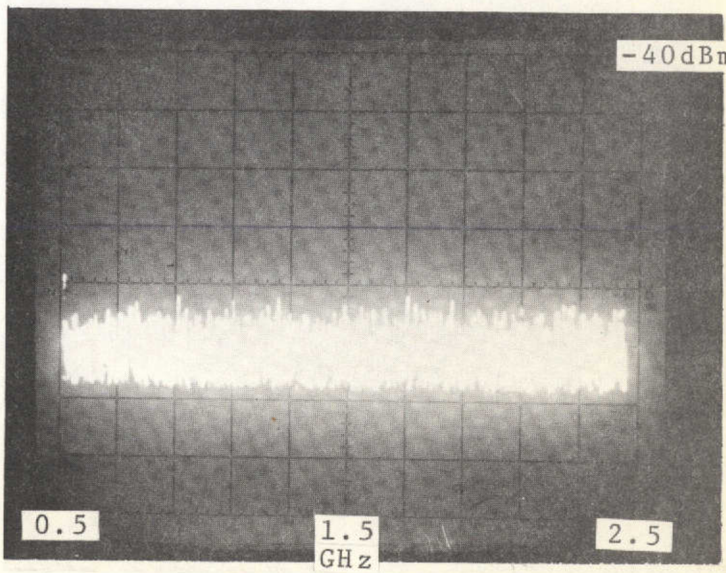
Test Point 2 Filter Pos. NONE

Location STBD F.B. Harbor___ At-Sea x

Date S BAND Note RADAR ON Observer HILL/POWELL

C-28

PHOTO C-3



Spectrum Display C-4

HARBOR AMBIENT

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 2203

Center Freq. 1296 MHz, Bandwidth 100 KHz

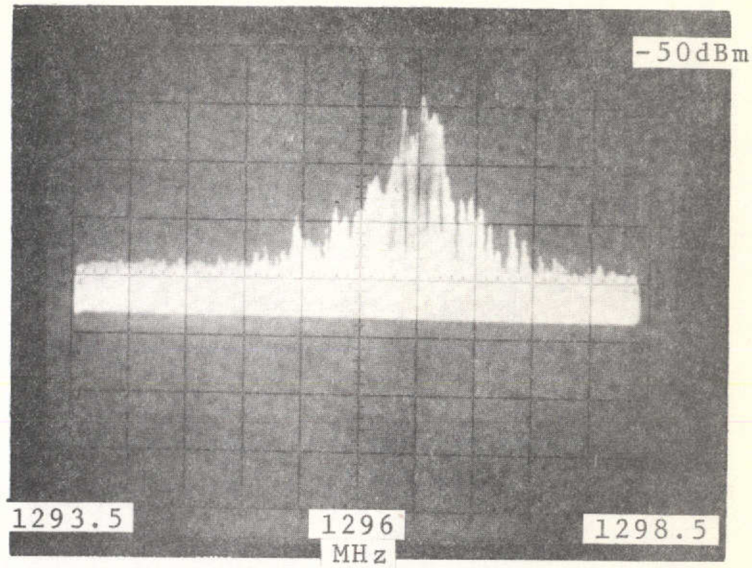
Scan Width .5 MHz/div, Log Ref Level -50 dBm

Test Point 1 Filter Pos. NONE

Location STBD FB Harbor PHILA At-Sea ____

Date ____ Note BOTH RADARS OFF SHORE SIGNAL Observer E.G.

PHOTO C-4



Spectrum Display C-5

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1520

Center Freq. 1500 MHz, Bandwidth 100 KHz

Scan Width 200 MHz/div, Log Ref Level -40 dBm

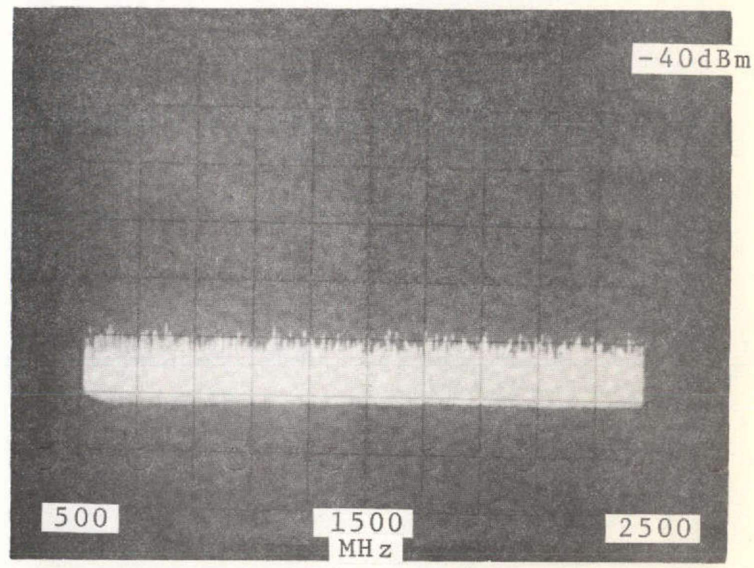
Test Point 1 Filter Pos. NONE

Location STBD F.B Harbor ____ At-Sea X

S BAND RADAR ON

Date ____ Note ____ Observer HILL/POWELL

PHOTO C-5



Spectrum Display C-6

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1527

Center Freq. 1500 MHz, Bandwidth 100 KHz

Scan Width 200 MHz/div, Log Ref Level -40 dBm

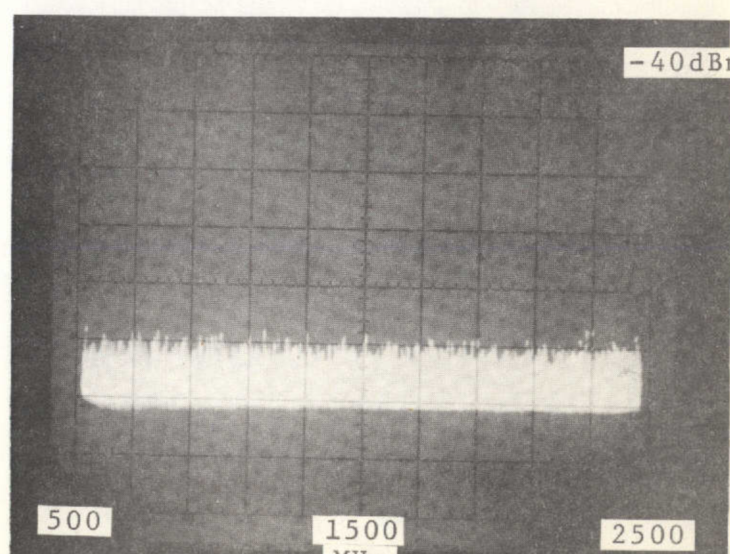
Test Point 1 Filter Pos. NONE

Location STBD F.B Harbor ____ At-Sea X

BOTH RADARS ON

Date ____ Note ____ Observer HILL/POWELL

PHOTO C-6



Spectrum Display C-7

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1946

Center Freq. 3050 MHz, Bandwidth 30 KHz

Scan Width 50 MHz/div, Log Ref Level -30 dBm

Test Point 1 Filter Pos. NONE

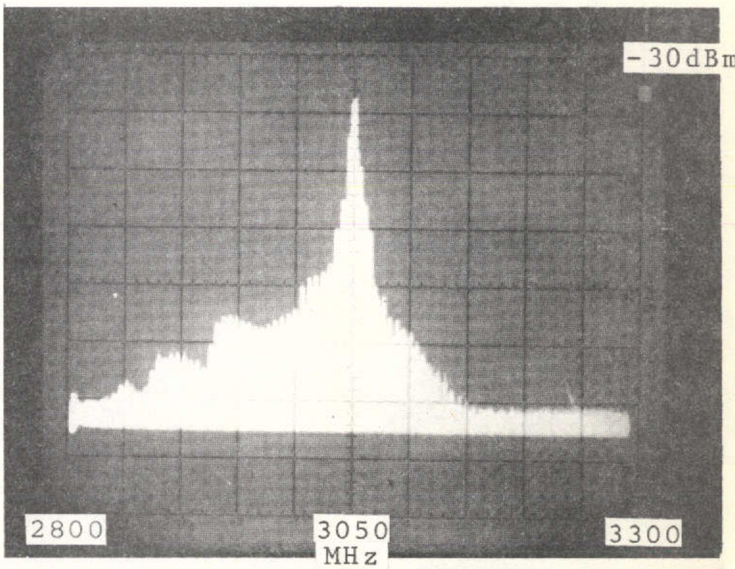
S BAND RADAR INTO 4 FT DISH

Location STBD F. B Harbor ______ At-Sea ✓

RADAR ANT. STATIONARY

Date ______ Note SCAN TIME 1 SEC/DIV Observer HILL/POWELL

PHOTO C-7



Spectrum Display C-8

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 2000 HR

Center Freq. 3060 MHz, Bandwidth 100 KHz

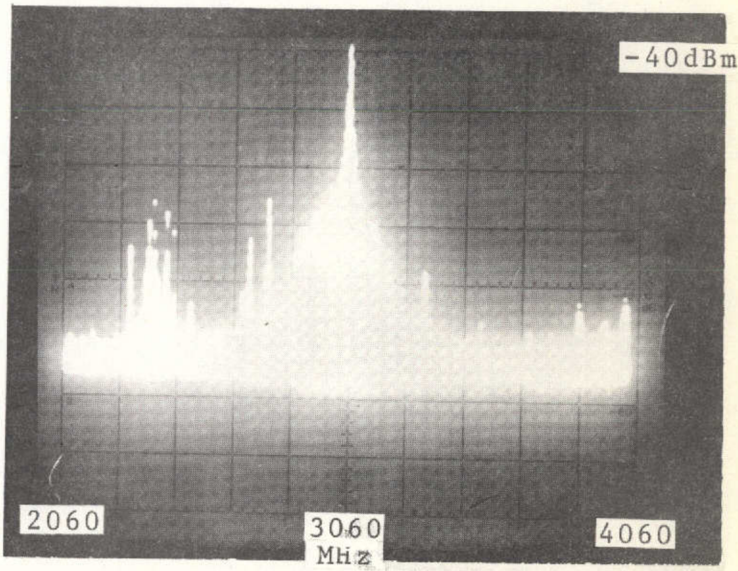
Scan Width 200 MHz/div, Log Ref Level -40 dBm

Test Point 1 Filter Pos. NONE

Location STBD F. B. Harbor IN RIVER At-Sea ______

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-8



Spectrum Display C-9

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1900

Center Freq. 1.5 GHz, Bandwidth 100 KHz

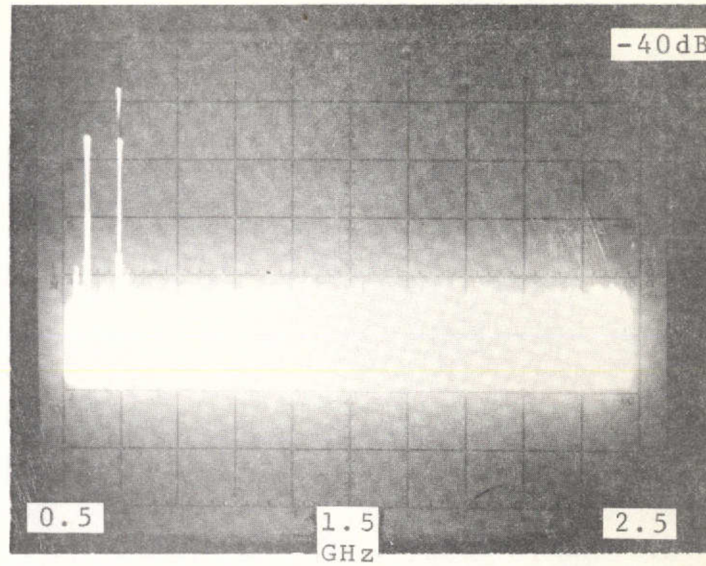
Scan Width 200 MHz/div, Log Ref Level -40 dBm

Test Point 1 Filter Pos. NONE

Location STBD F.B. Harbor ___ At-Sea X

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-9



Spectrum Display C-10

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1714

Center Freq 1.559 GHz, Bandwidth 100 KHz

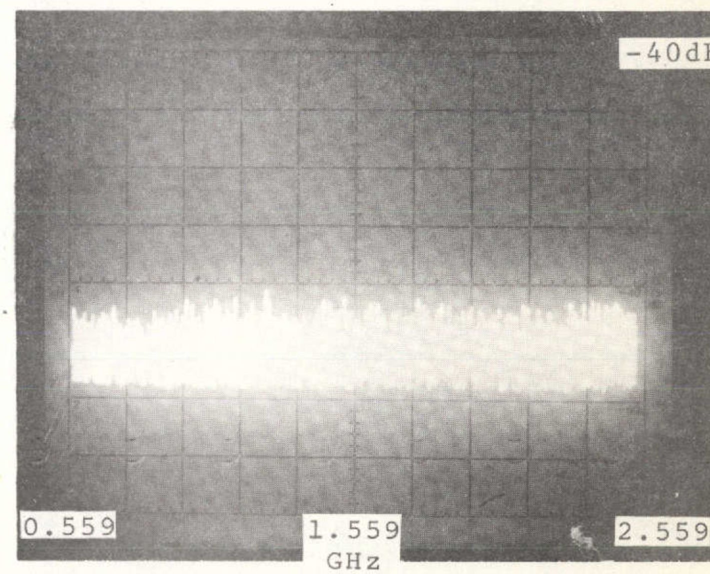
Scan Width 200 MHz/div, Log Ref Level -40 dBm

Test Point 2 Filter Pos. NONE

Location STBD F.B. Harbor ___ At-Sea X

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-10



Spectrum Display C-11

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74

Center Freq. 1.559 GHz, Bandwidth 100 KHz

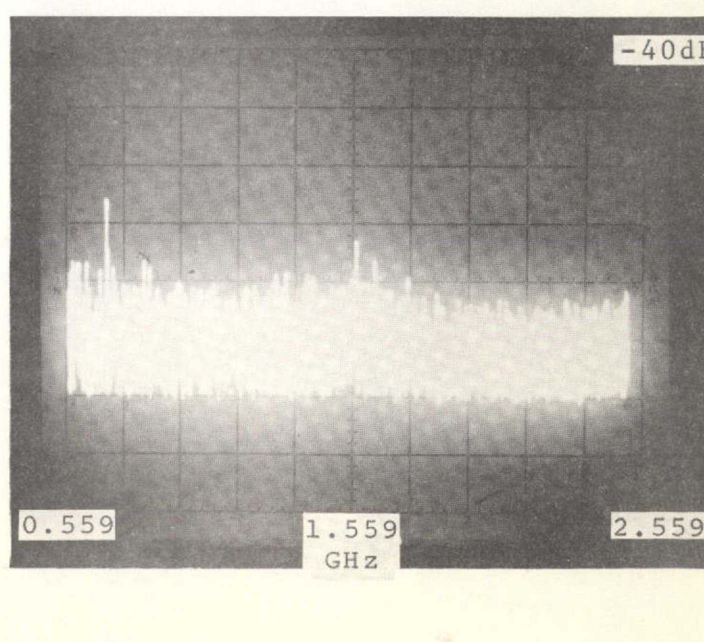
Scan Width 200 MHz/div, Log Ref Level -40 dBm

Test Point 3 Filter Pos. NONE

Location STBD F.B. Harbor ___ At-Sea X

Date 6/17/74 Note S BAND R.-ON Observer HILL/POWELL

PHOTO C-11



Spectrum Display C-12

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 2010 Hrs

Center Freq.___MHz, Bandwidth 100 KHz

2.07-6.15 GHz FULL BAND -40

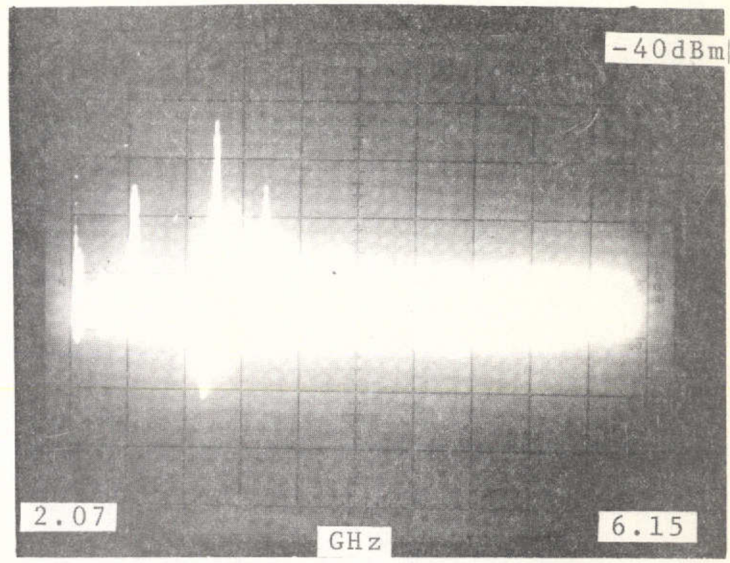
Scan Width___MHz/div, Log Ref Level ~~-30~~ dBm

Test Point 1 Filter Pos. NONE

Location STBD F.B. Harbor IN RIVER (DELAWARE) At-Sea___

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-12



Spectrum Display C-13

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1712

Center Freq.___MHz, Bandwidth 100 KHz

2.07-6.15 GHz FULL BAND -50

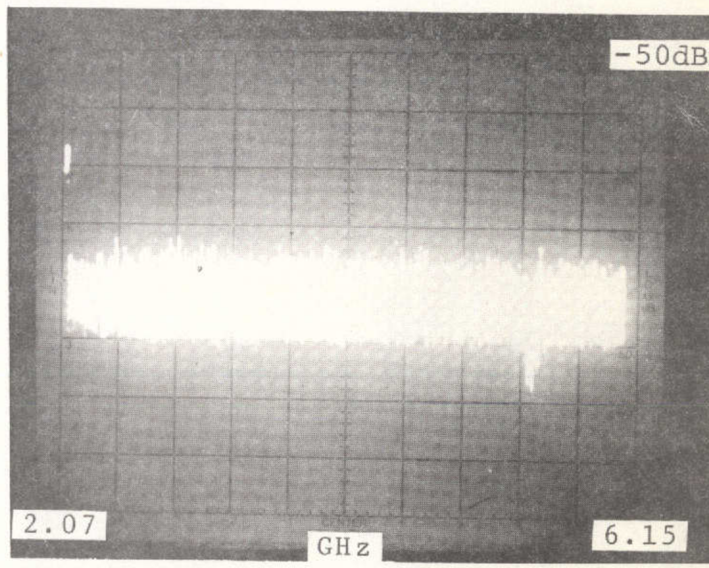
Scan Width___MHz/div, Log Ref Level ~~-40~~ dBm

Test Point 2 Filter Pos. NONE

Location STBD F.B. Harbor___At-Sea ×

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-13



Spectrum Display C-14

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1635

Center Freq.___MHz, Bandwidth 100 KHz

2.07-6.15 GHz FULL BAND

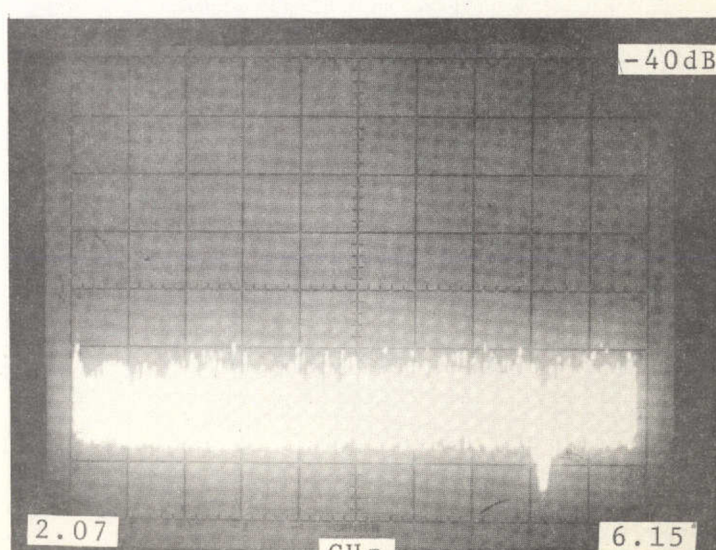
Scan Width___MHz/div, Log Ref Level -40 dBm

Test Point 3 Filter Pos. NONE

Location STBD F.B. Harbor___At-Sea ×

Date S-BAND Note RADAR ON Observer HILL/POWELL

C-32 PHOTO C-14



Spectrum Display C-15

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 2015 HR

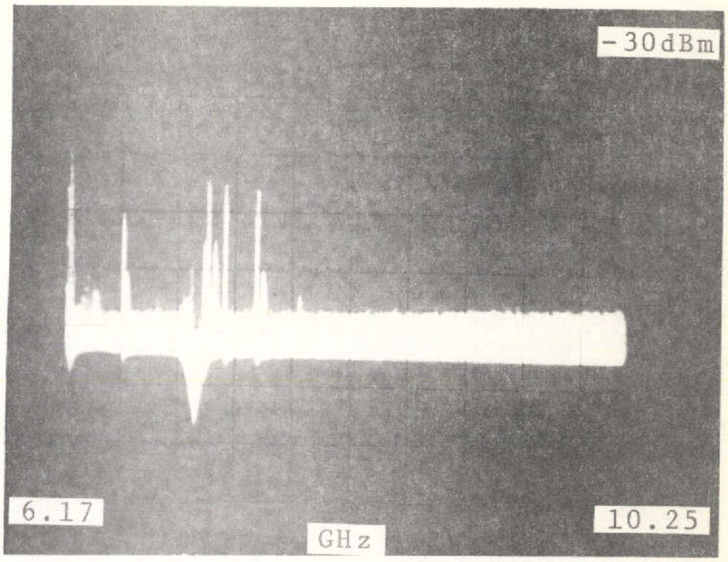
Center Freq.___ MHz, Bandwidth 100 KHz
6.17 ÷ 10.25 GHz FULL BAND
Scan Width___ MHz/div, Log Ref Level -30 dBm

Test Point 1 Filter Pos. NONE

Location STBD F.B., Harbor IN RIVER At-Sea___

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-15



Spectrum Display C-16

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1710

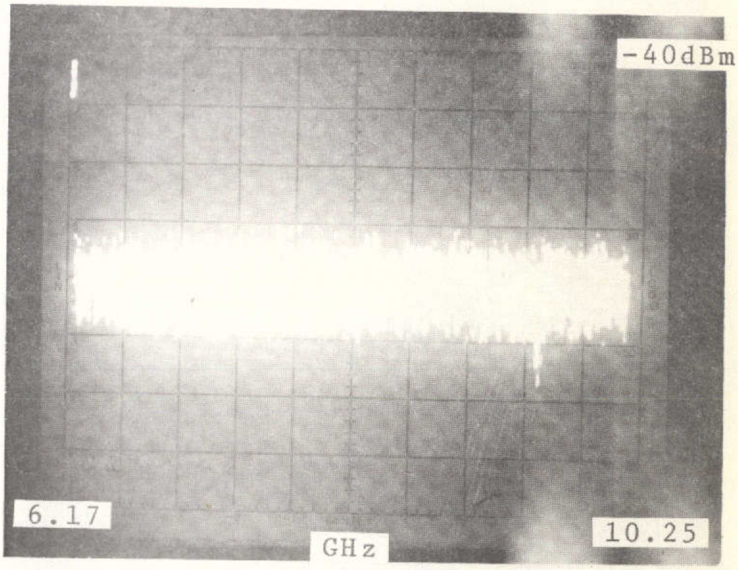
Center Freq.___ MHz, Bandwidth 100 KHz
6.17 - 10.25 GHz FULL BAND
Scan Width___ MHz/div, Log Ref Level -40 dBm

Test Point 2 Filter Pos. NONE

Location STBD F.B. Harbor___ At-Sea X

Date S BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-16



Spectrum Display C-17

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1640

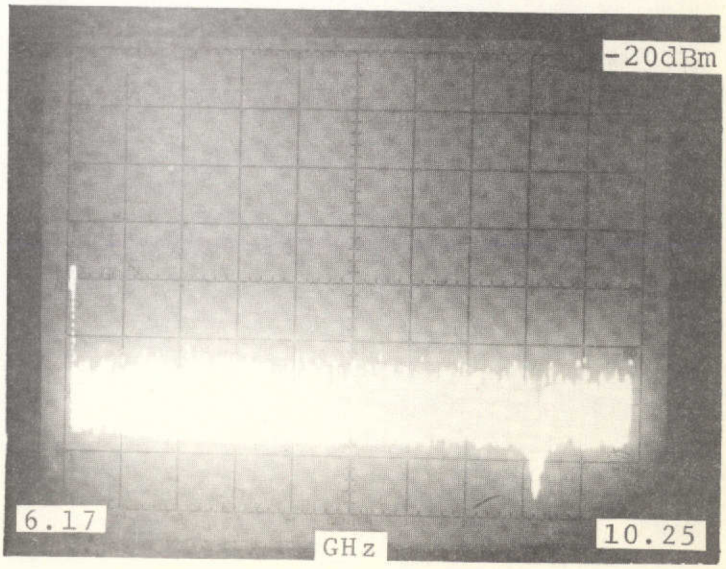
Center Freq.___ MHz, Bandwidth 100 KHz
6.17 - 10.25 GHz FULL BAND
Scan Width___ MHz/div, Log Ref Level -20 dBm

Test Point 3 Filter Pos. NONE

Location STBD F.B. Harbor___ At-Sea X

Date S-BAND Note RADAR ON Observer HILL/POWELL

PHOTO C-17



Spectrum Display C-18

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1110

Center Freq. 50 MHz, Bandwidth 100 KHz

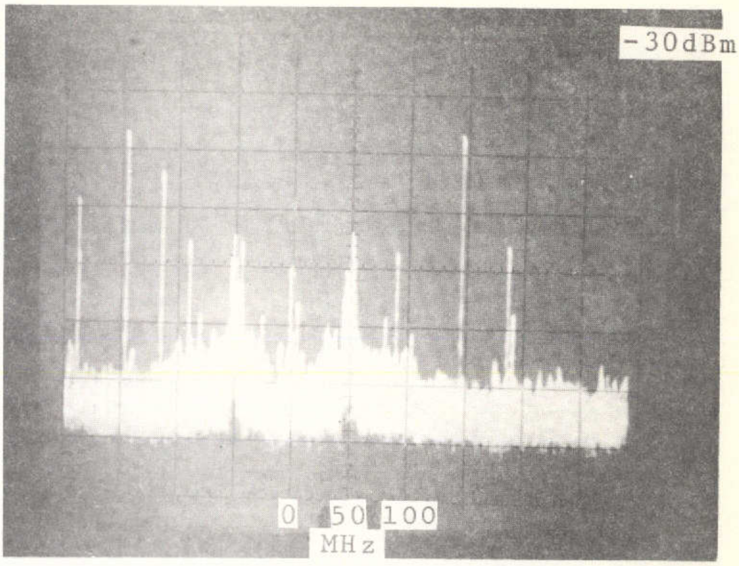
Scan Width 50 MHz/div, Log Ref Level -30 dBm

Test Point 4 Filter Pos. NONE

Location STBD FB. Harbor ✓ At-Sea ____

Date ____ Note BOTH RADARS OFF Observer EB

PHOTO C-18



Spectrum Display C-19

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1100

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 20 MHz/div, Log Ref Level -30 dBm

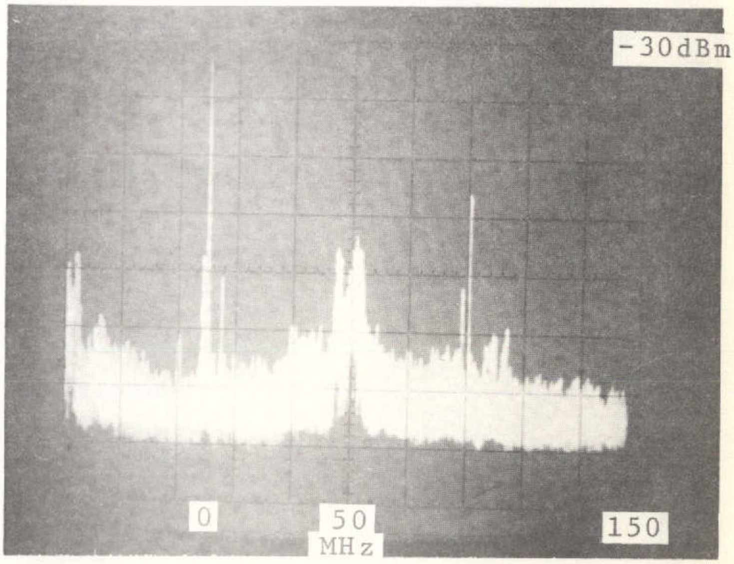
SCAN TIME 2 milli/sec/div

Test Point 4 Filter Pos. NONE

Location STBD FB. Harbor ✓ At-Sea ____

Date ____ Note BOTH RADARS OFF Observer EB

PHOTO C-19



Spectrum Display C-20

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/17/74 1105

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 20 MHz/div, Log Ref Level -30 dBm

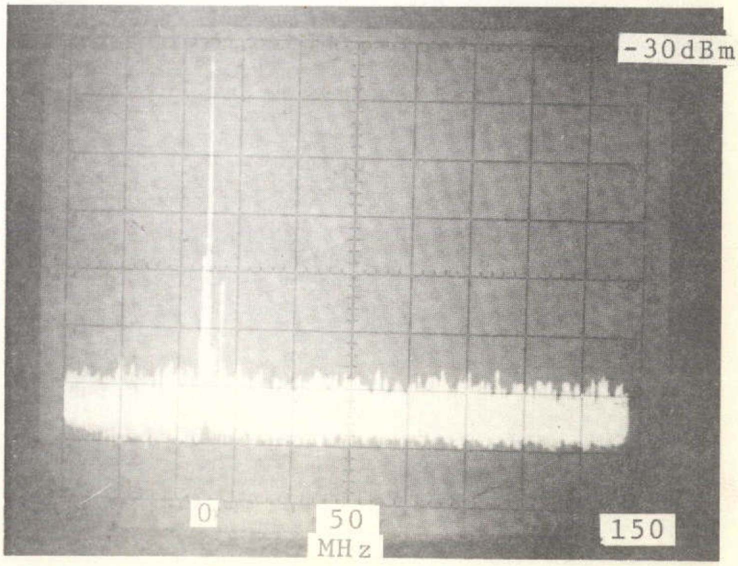
SPURIOUS RESPONSE IN SPECTRUM ANALYZER

Test Point NONE Filter Pos. NONE

Location STBD FB Harbor ✓ At-Sea ____

Date ____ Note BOTH RADARS OFF Observer EB

C-34 PHOTO C-20



Spectrum Display C-21

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/20/74 0805

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 5 MHz/div, Log Ref Level -30 dBm

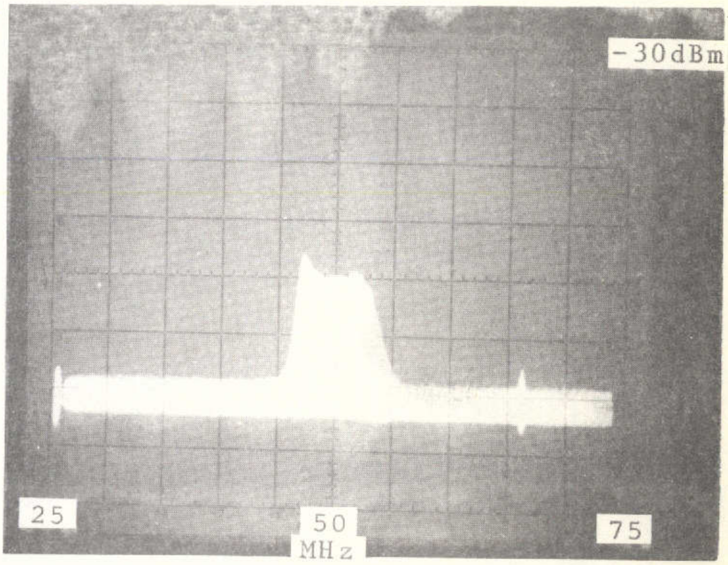
Test Point 4A After B.P. Filt. Filter Pos. IN AT TEST POINT (1)

BOTH RADARS ON

Location ______ Harbor SAVANNAH At-Sea ____

Date ______ Note SCAN TIME 1 SEC/DIV Observer HILL/POWELL

PHOTO C-21



Spectrum Display C-22

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/20/74 0750

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 5 MHz/div, Log Ref Level -30 dBm

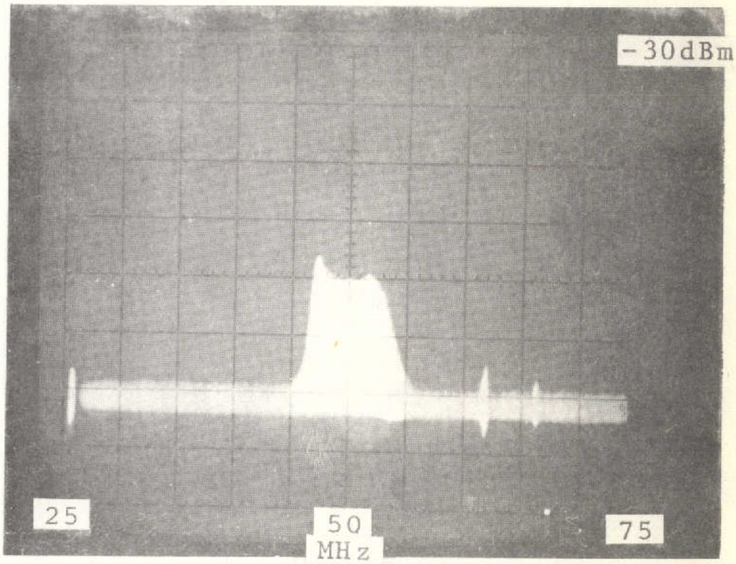
Test Point 4A After B.P. Filt. Filter Pos. NONE

BOTH RADARS ON

Location ______ Harbor SAVANNAH At-Sea ____

Date ______ Note 1S/DIV. Observer HILL/POWELL

PHOTO C-22



Spectrum Display C-23

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1500 Hrs

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 10 MHz/div, Log Ref Level -50 dBm

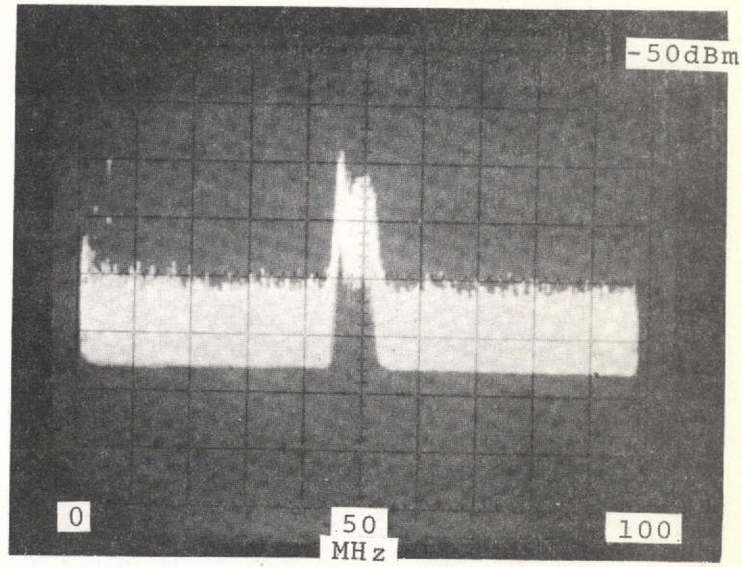
Test Point 4-A Filter Pos. NONE

Location STBD F.B Harbor ______ At-Sea X

RADARS ON ANTENNAS STATIONARY

Date ______ Note ______ Observer HILL/POWELL

PHOTO C-23



Spectrum Display C-24

Shipboard L-Band Terminal EMI Survey

Ship ALLIANCE Date 6/19/74 1505 Hrs

Center Freq. 50 MHz, Bandwidth 100 KHz

Scan Width 10 MHz/div, Log Ref Level -50 dBm

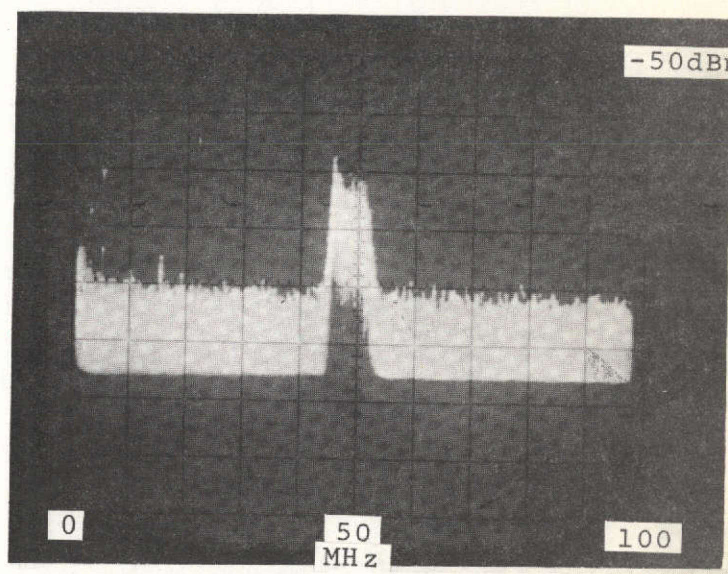
Test Point 4-A Filter Pos. FILTER IN 1

Location STBD F.B. Harbor ______ At-Sea X

RADARS ON, ANTENNAS STATIONARY

Date ______ Note ______ Observer HILL/POWELL

PHOTO C-24



Distribution:

Harry Feigleson
Maritime Administration
14th & E Streets, N.W.
Washington, D. C. 20235

Ron Walker
AII Systems
344 New Albany Road
Moorestown, N. J. 08057

O. J. Hanas
AII Systems
344 New Albany Road
Moorestown, N. J. 08057

Tom Calvit
COMSAT General Corporation
950 L'Enfant Plaza South, S.W.
Washington, D. C. 20024

John Clarke
Department of Transportation
Transportation Systems Center
Cambridge, Mass. 02142

John Carros
USCG Headquarters (GDST/62)
400-7th St., S.W.
Washington, D. C. 20590

Scientific Atlanta, Inc.
Box 13654
3845 Pleasantdale Road at
N.E. Expressway
Atlanta, Georgia 30324
Attn: Mr. Thomas J. Kelly
Director, Maritime Systems
Electro-Systems Division

LCDR Robert Fenton
U.S. Coast Guard (G-OTM/74)
Washington, D. C. 20590

Harold Kimball
Office of Telecommunications
Department of Commerce
Washington, D. C. 20230

Mr. Henry G. Catucci, Vice Pres.
Western Union International
2100 M St., N.W., Room 303
Washington, D. C. 20037 (2 copies)

RCA Global Communications, Inc.
60 Broad Street
New York, N.Y. 10004
Attn: Mr. R. Capozzi
Sr. Subcontract Admin.

Federal Communications Commission
1919 M Street, N.W.
Washington, D. C. 20554
Attn: Ray Crowell

ITS/OT
Department of Commerce
Boulder, Colorado 80302
Attn: Mr. Gene Adams

Capt. William Kolbe
United States Lines
1 Broadway
New York, N.Y. 10004

Department of Transportation
Federal Aviation Administration
800 Independence Ave., S.W.
Washington, D. C. 20590
Attn: Mr. Frank Carr, Code RD-140

The Magnavox Company
2829 Maricopa Street
Torrance, California 90503
Attn: Mr. K. W. Harris

Mitre Corporation
1820 Dolly Madison Blvd.
McLean, Virginia 22101
Attn: Mr. Bob Karminsky